Volume 58 | December, 1944 | $4.00 a Year
Number 4 | Pages 293-403 | $1.25 a Number

JOURNAL

OF THE

New England Water Works Association

ISSUED QUARTERLY

Published by
THE NEW ENGLAND WATER WORKS ASSOCIATION
613 Statler Building, Boston, Mass.

Entered as second-class matter September 23, 1903, at the Post Office at Boston, Mass., under Act of Congress of March 3, 1879
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THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 800 men. Its membership is divided into six classes, viz.:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

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This Association has at least eight regular meetings each year, of which five are held in Boston, one in northern New England, one in southern New England, and one, the annual convention, held in September on such date as the Executive Committee may designate.

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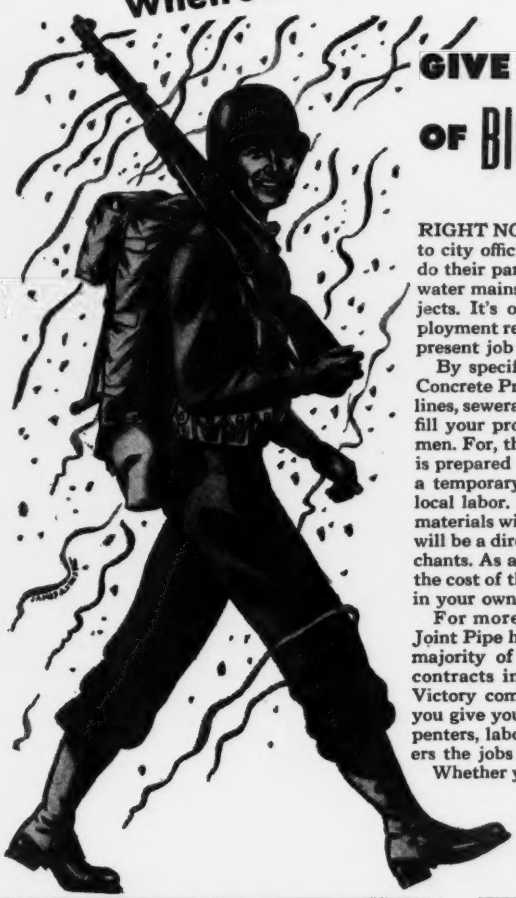

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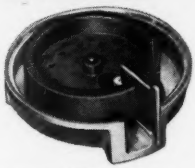

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	Class 150	5.0	5.9	6.7	8.0	9.4	11.6	15.2	18.0	29.9
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	Class 50	21.3	26.8	33.0	38.6	45.6	60.1	96.2	136.0	
	Class 100	29.4	39.3	50.4	62.5	76.4	107.5	164.2	230.5	
	Class 150	41.1	55.5	69.8	87.2	106.8	152.1	241.7	346.5	
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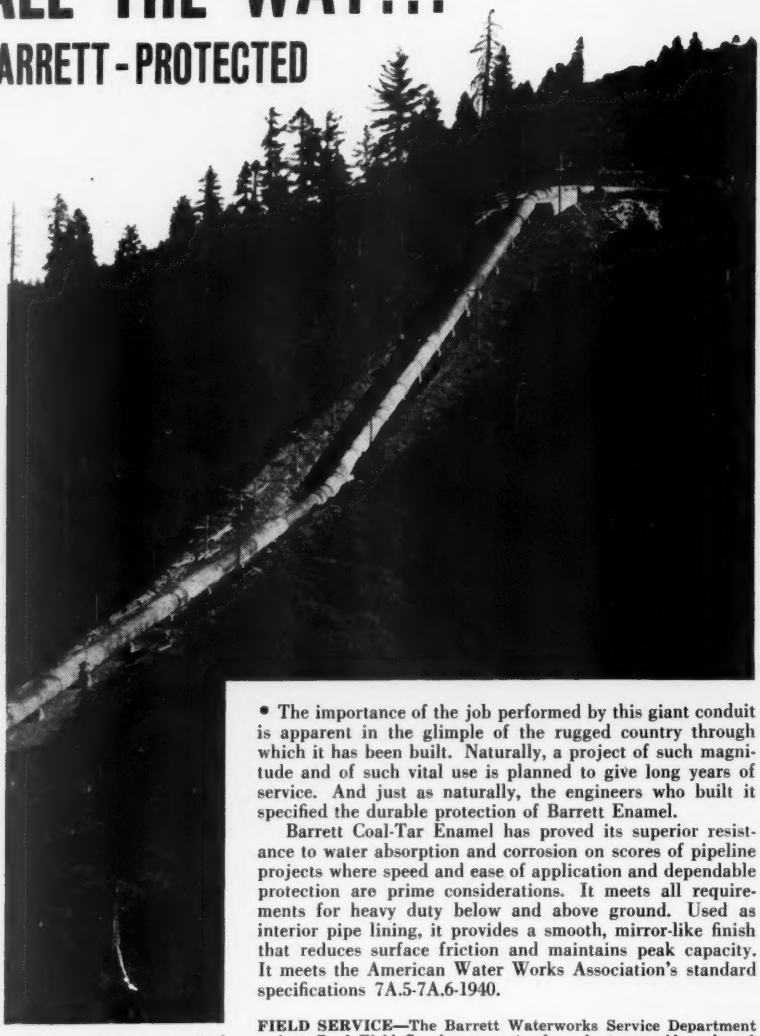

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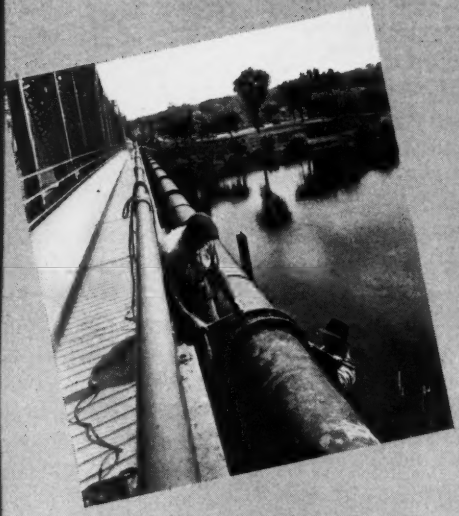

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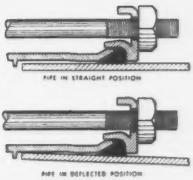

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New England Water Works Association
ORGANIZED 1882

VOL. LVIII DECEMBER, 1944 No. 4

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NOTES ON WATER SUPPLY IN NORTH AFRICAN CAMPAIGN

BY WILLIAM E. STANLEY*

[Read September 20, 1944.]

These notes, relating to the supplying of potable water in two phases of the North African Campaign, are based on personal recollections of activities extending over a period from September 1942 to December 1943. The confusion incident to a rapidly moving and quickly changing military situation together with the extreme pressure under which every staff officer operated during the campaign and for months afterwards in preparation for other campaigns, has dimmed the memory of many of the technical details which would be interesting to water works men.

Military activity in a theatre of operation does not permit the collecting and bringing away of any considerable amount of experience data. Shifts in duties and in location were sudden and with little opportunity to finish the job in hand or to review what had been done. Thus, this paper will be a rather general narrative, with a minimum of definite technical data.

The North African Campaigns. The North African Invasion Campaign of November 8 to 11, 1942, involved three major task forces, which may be designated for this story, as Task Force No. 1, comprising U. S. troops organized in the U. S. and landed in Morocco in the vicinity of Casablanca; Task Force No. 2 comprising U. S. troops organized in England and landed in Algeria in the vicinity of Oran; and Task Force No. 3, mainly English, which landed in Algeria near Algiers. The tactical plan for the three task forces called for a D-day convoy landing on November 8, a D+3 day convoy landing on November 11, and a D+13 day convoy arriving on November 21 with supply convoys scheduled to arrive semi-monthly thereafter.

*Professor of Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

The initial tactical operations of these three task forces lasted three days and within less than thirty days the responsibility for development of water supply in the three areas was transferred to the Atlantic Base Section at Casablanca, the Mediterranean Base Section at Oran, and the British Line of Communications at Algiers.

The Tunisian Campaign started immediately after the completion of the initial landings and ended with the surrender of the German Army in Northern Tunisia in May 1943. These notes relate, primarily, to experiences with Task Force No. 2 and the Mediterranean Base Section in Algeria, particularly around Oran and to an assignment as Water Supply Officer with a Railway Operating Battalion in the vicinity of Tebessa during the Tunisian Campaign.

Local Water Supplies in North Africa. In general, the areas of operations in the North African campaigns were located in the temperate, semi-arid zone lying between the coast and the mountain ranges which bound the Sahara Desert. The year comprises a dry season and a wet season. During the summer months practically no rain falls. However, during the months of December, January, February, and March extremely heavy rains occur.

Algeria in the vicinity of Oran was particularly difficult with reference to water supply because most of the ground waters contain too heavy concentrations of salts. As a typical example, the principal supply of the City of Oran, which has a reported population of about 400,000, has a sodium chloride content ranging from 3,000 to 4,000 ppm and a hardness of about 1,350 ppm. The so-called sweet water supply of Oran has a sodium chloride content of about 780 ppm. There are many wells in the Oran area, but few with a chloride content less than 1,500 ppm. Early after the landings it was found that our troops could drink water with a salt content up to about 1,500 ppm.

Many of the farm water supplies are from open dug wells ranging from 20 to 40 ft. in depth. Some of these wells have two or more galleries excavated in the water-bearing strata 40 to 60 m in length. A few drilled wells were found, one or two extending to depths of about 100 m.

City supplies are often from springs, sometimes located considerable distances away—for example, the City of Ouijda is supplied by

two springs, one located about 14 miles to the southwest and the other about 16 miles to the southeast. In general, the city water supplies were inadequate, and rationing had been in practice prior to the entrance of our troops. Most cities rationed their water by simply shutting off the entire supply at a certain hour in the evening or afternoon and furnishing no more water until the next morning.

In Oran, rationing was accomplished by requiring everybody on one side of the street to turn off their water for 24 hours every other day, while those on the other side of the street turned their connections off on the alternate days. Every building with plumbing was equipped with a storage tank, so the shutoff did not mean that the water usage was reduced entirely. However, the overall average daily per capita water consumption was about 10 gallons prior to the arrival of American troops.

In Algeria, there are several large irrigation projects which receive water from streams near the foot of the mountains. In a number of cases, these irrigation canals were used for troop watering, but it was a difficult job to remove the turbidity. Prior to November 1942 there had been seven years of low rainfall and the ground water levels had been progressively dropping. In December, following the allied landings, heavy rains started and turned the ground water level curve up. It has been rising ever since. The native Arabs considered the heavy rains which came shortly after the invasion a good omen.

In Tunisia, the water supplies are relatively freer of salt, but they are fewer in number and sometimes are badly polluted by human and animal wastes from Arab villages located near the water source. In many cases, the water source is one which had been developed by the Romans.

Advanced Planning. The preparation of Task Force No. 2 in England included considerable study of the anticipated water supply problems. The intelligence reports indicated that water supply in the area assigned to this task force would be critical. Accordingly, water supply was given a high priority, and two water supply companies (separate) were included in the troop list in addition to the water supply facilities of the combat and aviation engineer battalions. Later these two companies were supplemented by a water supply battalion.

There was only one water supply company (separate), in the British Isles and there was neither time nor transportation to obtain a second company from the United States prior to D-day. So it was necessary for the Engineer, Operations and Training Division, to activate a second water supply company (separate) by taking a cadre of officers and men from the original water supply company (separate). Also, for the North African invasion it was decided to enlarge the standard water supply company by adding a Well Drilling Section of one officer, four sergeants and eight other grades together with two well drilling rigs and considerable auxiliary material.

The enlarged water supply companies each included 5 officers and 137 enlisted men with major equipment comprising 7 1,500-gal. semi-trailer water tanks, 20 700-gal. tank trucks, 2 mobile purification units, 2 well-drilling rigs, 14 trucks ranging from ¼-ton to 2½-ton and 6 1-ton trailers. Also these two companies were allowed to take with them three sets of portable water units, each including a filter, a pump and a chlorinator and auxiliary items. These water supply companies proved very satisfactory and each was able to handle up to 14 water points and to haul almost 200,000 gal. of water per day with its tankage capacity of 25,000 gal. per company.

In addition to the two special water supply companies there were three combat battalions, four aviation battalions, two port battalions and one General Service Regiment included in the first three convoys all fully equipped with standard allowance of water supply equipment.

Shortly before the sailing date for the D-day convoy, orders were received that a supply of drinking water should be taken with the troops. An amount of approximately 300,000 gal. was required. For this purpose 5-gal. water cans are generally used. However, the available 5-gal. cans were all required for gasoline, so 55-gal. steel drums were decided upon for water containers. This proved to be quite a job as 5,500 drums had to be obtained, cleaned, painted inside, filled with safe drinking water and transported to several docks all in the space of a few days.

The following abstract from a field operations report gives some pertinent information on this project:

"No small drums suitable for our purposes were available. However the Ministry of Supply made available through Victor Blagden, Ltd., Barking, the following drums which were used after processing by U. S. forces:

"1. 1,863 lacquer lined, 55 U. S. gallon drums of American manufacture which had contained Ethylene Glycol. Washing with pure water and painting drum heads was the treatment required.

"2. 3,637 unlined steel drums of British make. It was necessary to clean and line these drums with 'Dukeron,' a bitumastic paint containing Trichlor Ethylene as a vehicle.

"Blagden furnished space and plant for processing the drums, personnel for instruction and supervision and some motor transport. Otherwise the entire job of hauling from storage, washing, lining, hauling to railhead, filling with water, marking for shipment and loading into railway wagons was done by U. S. troops.

"Operations were started Sunday 27th September and continued during all daylight hours, approximately twelve hours each day. At the close of work on 1st October all drums had been processed and placed at the railheads. At noon 3rd October filling with water and stencilling of all but final markings, not yet released, had been completed. Platforms, ramps, etc., had meanwhile been built at both railheads for quick loading.

"At 2,000 hours on 6th October final markings were released. Stencils were cut and marking and loading out commenced at daylight 7th October. The provision had been made for night lighting. It was unnecessary to use it as the entire shipment was loaded by 1,900 hours 9th October working daylight hours only."

These steel drums filled with water were sent by rail to 40 ships in groups ranging from 40 to 400 drums per ship. Of the 5,500 drums, 189 were lost due to leaks or breakage en route and 337 were left stored at King George V Dock near Liverpool. Thus, 4,974 drums were loaded on transports. Some weeks after the landings an inventory was made and about 3,100 of the drums were located still being used for water supply. Also a considerable number had been taken east by troops moving toward Tunisia. This size of water container, which weighs about 500 lbs, was too large and was not used in the Sicilian or Italian landings. Although it served quite well in the Task Force No. 2 landing, partly because it was possible to unload many of the drums at docks. Many were still in use in Oran as late as December 1943.

In addition to the initial supply of drinking water from London, it was necessary to estimate, while in England. the water supply needs of equipment and supplies for hospitals and all other military installations, except for combat troops, for five supply convoys which were to be forwarded semi-monthly following the three initial, D-day, D+3

day and D+13 day, convoys. Since many of the base installations were to be located in cities it was necessary to anticipate the use of municipal water supplies and to provide sufficient chemicals, including calcium hypochlorite for sterilization and lime and soda ash for softening water for railroad use.

These supply estimates were circumscribed on the one side by extremely limited tonnage allowances and on the other hand by very limited and uncertain technical data on local water supplies in North Africa. Most of the technical data were obtained from a military reconnaissance dated 1909; curiously, later experience showed these old data to be reasonably accurate.

En Route to North Africa. The trip from Scotland to Oran was devoid of any exciting incidents. It was a calm eleven days of floating on the ocean in the center of a convoy with six or seven destroyers riding herd. A count of ships and the knowledge that each carried 6,000 or more fully trained and equipped men left no doubt that a strong striking force was moving.

En route, the troops were informed of the water supply situation, were told of the danger of cholera, typhoid, dysentery, and especially schistosomiasis (Bilharziasis) commonly called "the snail disease" which was anticipated in North Africa. The description of the latter disease and how certain snails served as hosts had quite a beneficial effect on many of the troops as most of the open streams in North Africa are infested with snails, but certain of the streams are clear, sparkling and apparently good to drink. (A survey in September 1943 by a Medical General Laboratory did not locate any Bulinus snails in any water being used for army use.)

The troops were also issued the English individual water sterilizing kits, each including 50 calcium hypochlorite tablets and 50 dechlorinating tablets, and the use of the tablets was explained so that each individual might sterilize his own canteen full of water in case of necessity.

The following abstracts from instructions on water supply prepared in route and issued to all unit commanders on November 11, 1942, include information which may be of interest:

"SUBJECT: WATER SUPPLY, ORAN AND VICINITY"

"1. From information now available, the municipal water supply of Oran comes from three main sources outside the city. The salt content of this water and contamination make it unsafe. It must not be used by organizations until approved by the Medical Corps. The natives have become adjusted to the water, but Americans have not. In addition, the water supply is so short in the city that one part of the city receives water on one day and the other part receives its share the following day. Water venders sell 'sweet' water throughout the city in bottles which have been carted from small outside springs. This water is not a safe supply. All troops are ordered to get their supplies from approved water distributing points.

"2. The following precautions should be rigidly adhered to and observed by every individual before leaving this ship:

"*a.* Drink plenty of water shortly before debarking.

"*b.* Make certain your canteen is *full* as you get off the ship.

"*c.* Drink as little as possible after debarking until you have located an approved supply.

"*d.* Have and keep in your possession the issued sterilizing outfit for use with water canteens.

"3. If an occasion arises wherein the water you get has to be purified by the individual, remember the following facts:

"*a.* Boiling the water for a five-minute period will destroy all harmful bacteria. Thus, any tea or coffee prepared by boiling has this beneficial factor.

"*b.* When using the sterilizing outfit, add one white tablet first to the canteen and then wait *thirty minutes* before adding the blue tablet. Also make certain the sterilizing kit is kept in a dry place on your person. (See detailed instructions on lid of kit box.)

"*c.* If you must use the U. S. issued HTH or (calcium hypochlorite) capsules, remember they are designed for Lyster bag or 36 gallons. The large capsule can be used in individual canteens however, by making a concentrated solution by dissolving the contents of one capsule in a full canteen of water. The canteen cap when inverted is then used as a measure for the concentrated solution. One cap full of the solution when added to a canteen containing doubted water should remove the existing bacteria after a thorough shaking and allowing to stand for thirty minutes.

"*d.* Water which may be polluted by amoebic dysentery or infected snails (Bilharziasis) cannot be considered safe on chlorination alone. Thus, any local water should be boiled until its use is approved by the Medical Corps.

"*e.* Water distribution points will be established by the Corps of Engineers and approved by the Medical Corps as soon as possible. Thereafter, all water for drinking purposes must be obtained from these approved points.

"4. Water discipline is a function of command. The commander of each

unit or detachment is responsible for water discipline within his unit. The Medical Corps and Corps of Engineers are jointly responsible for water supply; however, the INDIVIDUAL COMMANDER is solely responsible that his men drink or bathe in safe water. Remember, water from wells, springs, taps, or faucets is not safe until approved."

Invasion Water Supply Activities. The first two convoys, namely the D-day and the D+3 day convoys, have been officially designated as comprising the active invasion of North Africa. All active resistance had ceased prior to the arrival of the 3rd or D+13 day convoy.

The original water supply company (separate) was sent with the D-day convoy and one Staff Water Supply Officer, Capt. R. M. Leggette, C. E. (on leave from the Ground Water Division of the U. S. Geological Survey). The main part of this company landed on the beaches east of Arzew and very shortly thereafter had established a water point on the beach. The next day this point was moved to the docks in Arzew where water was taken from ships.

The first local supply was taken from a spring at St. Leu, just east of Arzew. However, this water was too salty and had to be diluted with water from the ships. Experience indicated a 50 per cent dilution would provide a satisfactory drinking water. (Tests later showed the spring water had about 3,000 ppm sodium chloride and the acceptable water about 1,500 ppm.) On the 11th of November a concrete tank holding about 30,000 gal. had been located. It was cleaned and put in service as the Arzew water distribution point. The supply for this water point was obtained from ships and hauled from the St. Leu spring until about November 18 when a fleet of 7 5,000-gal. wine trucks was leased and started hauling water to this water point from the Oran sweet water supply, a distance of about 25 miles.

The D+3 day convoy landed at Mers-el-Kebir just outside of Oran. This convoy carried a very large number of troops, so water supply was given first priority and continued in that position for the first two weeks.

The instructions of the Corps Engineer to the Water Supply Officer prior to debarking were as follows:

". . . will proceed at once to determine status of the town water supply paying particular attention to the reservoir supposedly existing south of the town, and

will determine from other staff agencies or individuals of Engineer organizations the status of the tactical water supply which was intended to be secured to the east. He will determine the location of water supply points established by the water supply company, and will visit at least one of these. He will then report in person to Engineer Hqs."

When it came time to debark, four officers, including the Water Supply Officer, were debarked in advance of other personnel. There was no transportation available, so the water supply reconnaissance did not extend very far into the country until a jeep was obtained the next day. It soon became evident that the City of Oran water supply was out of operation and must be put into operation promptly. Electrical transmission lines had been destroyed by shell fire and had to be rebuilt. The water supplies to the east of Oran were all inoperative because they depended on electrical power which was out of service by damage to transmission lines at St. Cloud by shell fire in the two-day battle with the Foreign Legion. St. Cloud was the junction of several transmission lines serving a large area. Accordingly, the first duty of the Water Supply Officer, who was also Utility Officer, was to get the power generation plant and the electrical transmission lines back into operation. No damage had been done to any water supply installation.

The Oran city water supply was in operation on a limited basis at the end of the third day with the aid of an old steam plant. The central power system was back into operation on Monday, November 16, or 6 days after the entrance of our troops into Oran. Very little damage had been done to the power generating plants. The rebuilding of the damaged transmission lines was all handled by the French power company personnel. In fact, the repair crews started to work as soon as the battle at St. Cloud was ended and some of our sentries mistook them for saboteurs. This necessitated a trip into St. Cloud when the Foreign Legion had ceased firing, which trip was a bit exciting as the villagers were quite bitter and some sniping was still in progress.

Military Water Supply in Oran Area. The problem of supplying water to troops in the Oran area involved two phases. First, the initial phase of supplying water to newly arriving troop units before their unit equipment became available and second, the making available of

water at designated watering points for troop units having sufficient equipment to transport their own water from the water points.

In the early stages of the North African Campaign it was necessary for the water company to furnish water drums and in many cases to deliver the drums to the troop units. Later, staging areas were established with water distribution points located in the areas at sufficiently frequent intervals that water could be carried by hand from the distribution points.

The main military water supply for troops in Oran and several miles around was taken from the Oran City Ras-el-Ain source of "sweet water" until the summer of 1943, at which time the demands of the city and the Port were greater than the supply of "sweet water" and it became necessary to develop another source. Fortunately in the several months of searching in 1942 and early 1943, several wells had been located having a salt content sufficiently low to be used for troop watering.

Prior to leaving England, the orders for the initial operations included the capturing of an irrigating reservoir near Arzew which it was expected would be useful as a principal source for water. On arrival in Algeria, the reservoir water was found to be too bitter for use owing to the several years of drought. Also the quick entry into Oran permitted the use of the more desirable Ras-el-Ain source. After the heavy rains in December, the reservoir water became sufficiently sweet for use, but water transport could not reach the reservoir without considerable heavy road construction. Later when the roads became passable and the water supply company was ready to establish a water source on the reservoir, one of the company officers discovered a spring in the hills one or two miles away which proved a better source. So a year after the invasion the most important water source anticipated from intelligence data in England was finally abandoned without being developed.

Another problem in the Oran City area was the furnishing of potable water to the large numbers of headquarters, messes, billets, Red Cross clubs, and hotels taken over for the use of American troops, water in the city mains being too salty and the sweet water distributed by bottle purveyors very dangerous. It was necessary to organize a "retail" water distribution not contemplated by the normal army water supply procedure.

The water supply company (separate) handled this, using a 450-gal decontamination tank truck which has a centrifugal pump mounted on it and a length of hose so that water containers, such as Lyster bags and 55-gal drums, could be filled in back rooms, or on the 2nd, 3rd. or 4th story floors.

Shortly after arrival in Oran, it became necessary to set up a schedule of water supply allowances as follows:

USE OF WATER

	Daily Allowance per capita
a. Drinking and cooking (units other than hospitals)	1 gal fresh water
b. Drinking and cooking (hospitals)	2 gal fresh water
c. All purposes (units other than hospitals)	2 gal fresh water
d. All purposes (hospitals)	5 gal fresh water
e. Washing and showers (units other than hospitals)	4 gal salt water
f. Washing and showers (hospitals)	5 gal salt water
g. Where water-borne sewage was approved	25 gal salt water

The operators of every water distribution point were instructed to record and report the amount of water taken by every unit served by the water point. An available record for the first 14 weeks indicates that the per capita water usage was kept below the specified 2 gal "all purpose use" with the exception of two weeks in December. During the summer of 1943, the amount of water hauled to dry points was reported to be in the magnitude of 750,000 gal per day.

Railway Water Supply—Tunisian Campaign. The American Sector for most of the Tunisian Campaign was in southwestern Tunisia with the principal supply railhead at Tebessa. The main rail supply line was the meter gage CFA railroad extending from Ouled Rahmoun, just south of Constantine, to Tebessa a distance of about 125 miles. This line was called upon to carry upwards of 1500 tons per day of supplies for the American 2nd Corps.

The two major operating problems included a lack of sufficient water and a continual breaking down of locomotives by boiler troubles due to scale and other troubles related to the use of a high mineral

content water. Early in March, the railway water supply stations became so depleted of water that many trains could not move for lack of water. Hasty surveys failed to locate any nearby supplies, and it was necessary to haul water from distances as far as 60 miles. The writer was assigned the job of locating additional supplies.

An estimate of the water supply requirements and the available water quantities for the nine watering stations was as follows:

ESTIMATED WATER QUANTITIES—GALLONS DAILY

Station	Required	Available		Additional Needed
		In March	In Summer	(Summer)
Ouled Rahmoun	60,000[1]	48,000	35,000	25,000
Taxas	30,000	16,000	10,000	20,000
Armandy-Ourkis	40,000	5,000	2,000	38,000
Canrobert	15,000	5,000	2,000	13,000
Ain-Beida	45,000	40,000	13,000	32,000
Oulmene	40,000	[2]	[2]	40,000
La Meskiena	35,000	25,000	12,000	10,000[3]
Youks-les-Bains	40,000	30,000	20,000	20,000[4]
Tebessa	75,000[1]	74,000	40,000	35,000
Totals	380,000	243,000	134,000	233,000

[1]Includes switching and shop use.
[2]No local supply. Water hauled from a distance of about 45 kilometers (28 miles).
[3]Assuming existing springs augmented from an adjacent irrigation canal; so quantity limited by pipe line capacity.
[4]Ample quantity of water at the springs; additional piping and treatment plant capacity needed.

All of the water supplies have a high hardness content. Some illustrative data are as follows:

Station	Hardness French degrees
Ouled-Rahmoun	38°2
Taxas	89° *
Armandy	34°4
Canrobert	42°
Ain-Beida	20°
Oulmene-Khenchela	164°4
La Meskiana	65°3*
Youks-les-Bains	16° *
Tebessa	41° *

*Treatment plants (Lime softening)

The development of additional supplies required considerable quantities of pipe which were not then available in North Africa. Also the enlargement of several treatment plants would have been necessary for any extended use of the railway. Fortunately the retreat of the Germans made the larger construction work unnecessary so far as military operations were concerned.

The searching for water supplies for this railroad was a strenuous, but very interesting experience. Practically every day for almost two months was spent riding in a jeep with the bed roll carried along and used every night with one exception. Meals were from cans or troop unit kitchens encountered in the travels. Practically every day seemed to be a rainy day. A part of the survey included the possibilities of rebuilding water supplies along the railways to the east of Tebessa as the Germans were pushed back.

Drilling of Wells. The preparations in England included equipment for well drilling. However, on arrival in North Africa plenty of wells were found, and the job was not the drilling of additional wells, but the searching for existing wells with a sufficiently low salt content to be useful for troop watering. The French had been searching for "sweet" water for 150 years, and it did not seem that we could improve upon their very excellent technical data in any short space of time. Accordingly, the French Water Supply Agency was consulted on many occasions.

Several months after arrival in North Africa a number of wells were drilled, some of which were successful in finding drinkable water. In one case a 4-in. well was drilled 1,250 ft. deep which provided 30 gpm of water for an airport for which water had been hauled for all of the operations following the invasion.

Incidents. Providing water for active military operations in North Africa was never an easy job. However, a few incidents seem to stand out in looking back on the several months of strenuous activity. These may be of interest and a few of them are very briefly outlined as follows:

1. Reporting to the Chief Engineer, SOS Headquarters, in England about 9 am one September morning it was quite a jolt to be given the assignment as Water Supply Officer and informed that final requisitions for the D-day equipment and supplies had to be ready by 5 pm that day.

2. About three days later another jolt was the order to provide 300,000 gal of water in suitable containers to be ready in five days for loading on ships, with no knowledge as to any supply of containers nor of local water supplies or loading facilities.

3. The activating of a second water supply company just a few days before departure of the D-day convoy was interesting, particularly since other officers were responsible for the operations.

4. Shortly after arrival in Oran an order was received at 10 pm to establish a water point and have it ready to issue water by 8 am the following morning at a location about 125 miles to the east in an area where no definite information had yet been obtained as to water sources. The telephone to the water company C.P. was "Out of order!" The motor pool had no available transportation! Fortunately a jeep was located, but no driver. So jeep driving was experienced in the dark without lights, over strange roads to reach the water company C.P. about 15 miles away. The officer sent with the water point detachment reported by telephone next morning that the water point was in operation at 8:15 am in time to furnish water to an armored force on its way to Tunisia.

5. The first days in North Africa were very strenuous for the one water supply company. The second company was needed badly. However, the relief to strained nerves when the second company arrived was short lived when a cable was received announcing the sinking of a ship carrying all the company equipment. Fortunately, the company commander was a resourceful man. Armed with orders giving him first priority on all depot stock and permission to requisition wine trucks, he was able to improvise equipment and get his company operating within three or four days.

Additional incidents could be recalled. Descriptions of the water supply activities of various troop units and descriptions of the various items of equipment used could very well extend this narrative.

GROUND-WATER STUDIES IN NORTHEASTERN MASSACHUSETTS[1]

BY M. L. BRASHEARS, JR.[2]

[Read September 20, 1944.]

Ground water has long been utilized as a satisfactory source for public water supplies in many parts of Massachusetts, particularly in the smaller communities or those of moderate size, but only during the past decade or so has it been used to any great extent by industry. The increased use of ground water was made practical by radical improvements in the construction of wells and pumping equipment. Some idea of the value of the ground-water resources of Massachusetts may be obtained from the following information. In 1940, according to the records[3] of the Massachusetts Department of Health, 256 of the 351 towns and cities in the state were served by public water supplies. The population of these communities was about 4,000,000, or about 97 per cent of the total population of the state. The public water supplies for 145 of these communities were obtained wholly or in part from wells and springs. In 1940, approximately 880,000 people were served from ground-water sources, the average withdrawal of the supply systems being about 60 mgd. An average pumpage of over one million gallons a day was maintained by fourteen of the ground-water supply systems, the largest withdrawal, about 5.6 mgd, being made at Lowell. The records of ground-water withdrawal for industrial purposes in Massachusetts are very incomplete, but information for Middlesex County indicates that the pumpage by private industries is at least equal to that of the public water works. Moreover, the use of ground water for industrial purposes is apparently increasing more rapidly than that for public supply. Despite this important use of ground water in Massachusetts, recharge exceeds withdrawals except in a few localities and there are

[1]Published wiht the approval of the Director of the U. S. Geological Survey.
[2]Geologist in charge, U. S. Geological Survey, Jamaica, N. Y.
[3]Annual Report of the Massachusetts Department of Health for the year ending November 30, 1940, pp. 147, 176-181, 197-198.

many opportunities throughout the state for developing additional sizable ground-water supplies.

The ground-water division of the U. S. Geological Survey, in coöperation with the Massachusetts Department of Public Works, has been making an investigation of ground-water conditions in Massachusetts since 1938. The ground-water studies are a part of a larger coöperative program that also involves geologic studies and topographic mapping. The chief purpose of the ground-water studies has been to obtain detailed information concerning the occurrence and availability of ground water in the state. Such data will provide a basis for the more effective utilization of the ground-water resources of the state. At the beginning of the coöperative program it was planned to continue the work from year to year until the entire state was covered. During 1939, the appropriation for this work was reduced to a very small amount, and the scope of the studies had to be curtailed. At the beginning of 1944, however, the funds for ground-water investigations were increased somewhat, and this has resulted in more rapid progress.

In general, the ground-water investigation has been divided into two phases of study. First, a number of observation wells were established for the periodic measurement of ground-water levels, in order that changes in ground-water storage may be followed. And secondly, a systematic collection of data concerning existing wells and related information has been made to determine the utilization and availability of the ground-water resources. Up to the present time, the work has been carried on chiefly in the northeastern part of the state, although several observation wells are being maintained in other parts of the state. The areas that have been covered are shown in Figure 1. Observation wells are maintained at all of the localities shown, and field studies have been made in the Lowell, Wilmington, Woburn, Winchester, and Cambridge areas.

In Massachusetts, the most favorable water-bearing material consists of the deposits of glacial sand and gravel that cover the bedrock surface. The largest ground-water supplies are obtained from the outwash that lies in the pre-glacial bedrock valleys. Some of the buried valleys in Massachusetts contain over 200 ft. of outwash material, but the valley filling in most places is relatively thin—com-

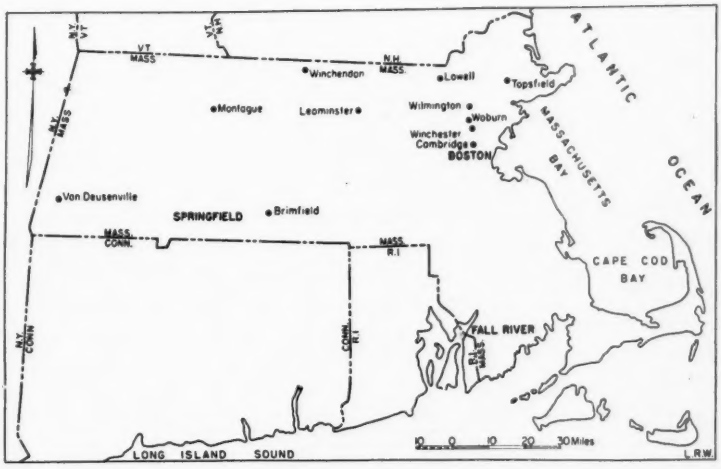

FIG. 1.—INDEX MAP OF MASSACHUSETTS SHOWING AREAS OF GROUND-WATER STUDIES

monly less than 100 ft. The position and trend of some of the valleys is not readily apparent, and their extent must be determined if the ground-water resources are to be effectively utilized.

It is known that a number of buried valleys and their tributaries exist in northeastern Massachusetts. In 1899, W. O. Crosby[4] suggested the existence of a buried pre-glacial channel of the Merrimac River, extending southeastwardly from Lowell to Boston Harbor. Later, I. B. Crosby[5] presented other evidence of the existence of buried valleys in the same region. Because considerable quantities of ground water are withdrawn from these buried valleys, it seemed desirable at the start of the ground-water investigation to begin work in Middlesex County. Accordingly, field work was begun in Lowell in 1938, and the field studies have been extended southward to Cambridge.

The largest ground-water withdrawals in the region that has been studied occur in the vicinity of Lowell and Woburn. More than

[4]Crosby, W. O. Geological history of the Nashua Valley during the Tertiary and Quaternary periods: Technology Quarterly, vol. 12, pp. 288-324, Dec. 1899.
[5]Annual Report of the Massachusetts Department of Health for 1936, pp. 55-60.

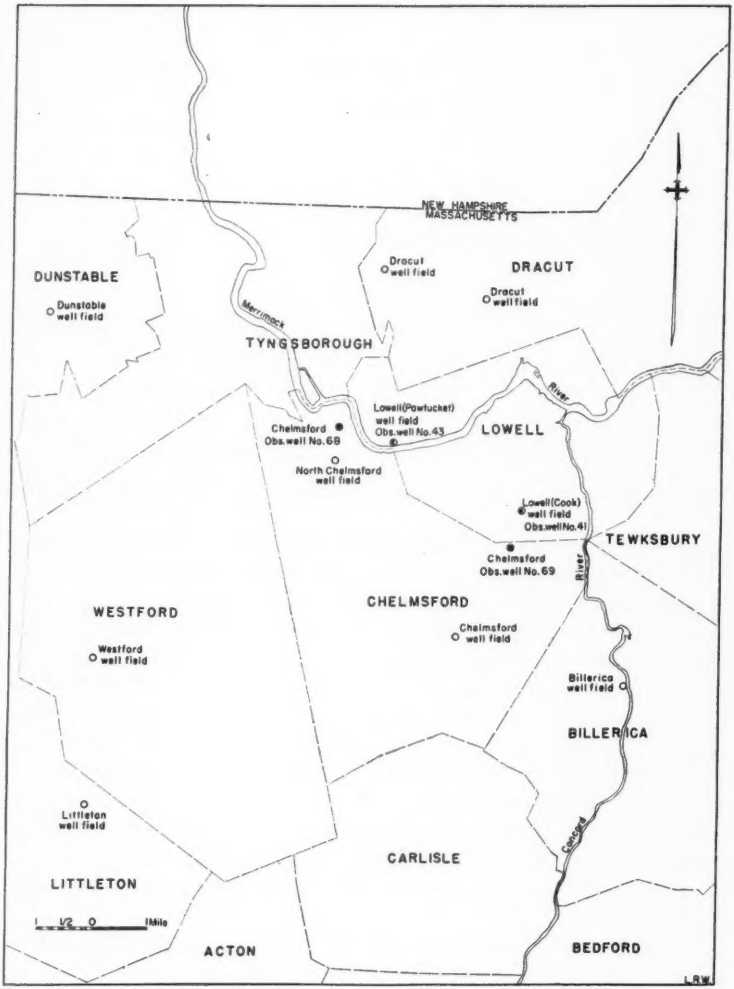

FIG. 2.—OBSERVATION WELLS AND PUBLIC GROUND-WATER SUPPLIES IN VICINITY OF LOWELL, MASSACHUSETTS

7 mgd are pumped in each area for public supply and industrial purposes. Throughout a large part of these areas, small to moderate supplies may be obtained from the bedrock and overlying glacial deposits, but large supplies are available only from the relatively thick outwash in the buried valleys. The wide distribution of favorable water-bearing deposits in the vicinity of Lowell is indicated by the data in Figure 2 which show the location of public pumping stations in the area. Large supplies are pumped from the wells of the city of Lowell which penetrate deposits lying in the pre-glacial gorge of the Merrimac River. At the other well fields, smaller supplies are withdrawn from shallower gravels which appear to lie, in nearly every case, in tributaries of the buried channel of the Merrimac River. In order to determine the course of this channel, the Geological Survey has made subsurface explorations in three areas in the vicinity of Lowell. This work was done by the Geologic Branch of the Geological Survey and was carried out by means of seismic surveys. As a result of the explorations, a bedrock channel filled with glacial drift was discovered beneath the broad valley between Lowell and Chelmsford, and the report[6] describing the results of the seismic work, points out that this channel does not continue southeastward but bends to the northeast just south of the city limits of Lowell.

The average withdrawal of ground water during the past 5 years for the public supplies shown in Figure 2 has ranged from about 5 mgd to 7 mgd, about 80 per cent of the total being pumped by the City of Lowell stations. The pumpage in the other well fields shown in Figure 2 averages from about 100,000 to 500,000 gpd. Industrial wells are scattered through the area, the largest single withdrawal being made at a plant adjacent to the Cook well field which pumps about 1 mgd.

The location of four of the observation wells maintained in the Lowell area is shown in Figure 2, and hydrographs for these wells since 1940 are given in Figure 3. Two of the wells, Lowell 41 and 43, penetrate the valley fill in the buried Merrimac gorge and are situated close to the pumped wells at the Cook and Pawtucket well fields of

[6]Lee, F. W., Farnham, F. C., Raspet, A: Seismic Method for Determining depths in Bedrock as applied in Lowell Quadrangle. Mass. Dept. of Public Works, Cooperative Geologic Project. Special Paper 3, p. 45, 1940.

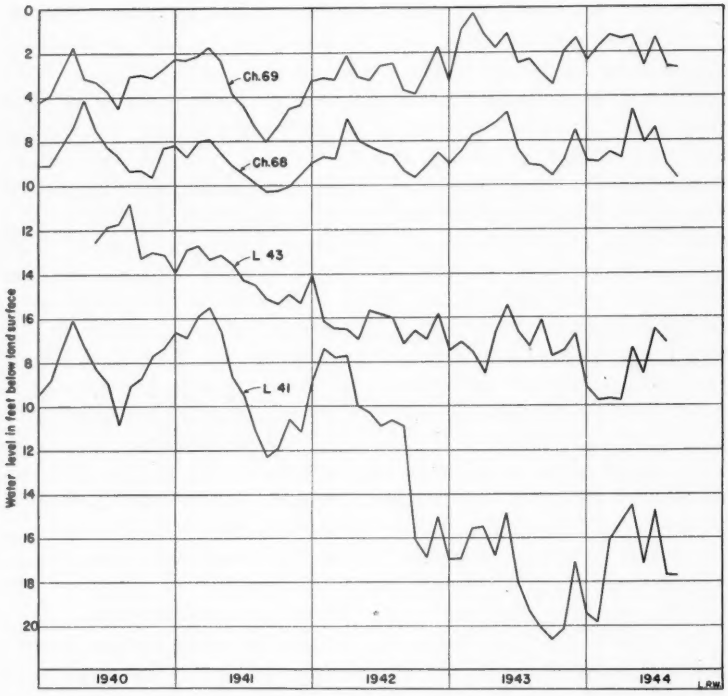

FIG. 3.—GROUND-WATER LEVELS IN VICINITY OF LOWELL, MASSACHUSETTS

the city of Lowell. The water level in Lowell 41 is also affected by nearby industrial pumping. The other two observation wells are located distant from pumping wells. One of these wells (Chelmsford 69) penetrates glacial outwash lying in a tributary of the buried Merrimac, to the south of the Cook well field, and the other (Chelmsford 68) taps deeper gravels to the west of the Pawtucket well field. A number of test wells have been drilled in the vicinity of Chelmsford 68 by the city of Lowell, and they indicate an abundance of water-bearing material.

The hydrographs are presented to show the trend of water levels in heavily pumped areas in contrast to the trend in areas unaffected

by withdrawals. Except for 1942, a deficiency in precipitation has occurred in each year since 1940. From January 1940 to August 1944 the accumulated deficiency, based on the average precipitation at Boston of 40.8 in., for the previous 73 years, amounts to 26.5 in. The deficiency amounted to 4.8 in. in 1940, 10.0 in. in 1941, and 8.6 in. in 1943, with an excess of 1.7 in. in 1942. By the end of August, a deficiency of 6.7 in. had been accumulated in 1944. Despite the lowered rate of precipitation, there has been no great decline of water levels in wells Chelmsford 68 and 69. Both of the wells show normal seasonal fluctuations which vary from year to year in accordance with variations in rainfall. As would be expected, the lowest stage in each of the wells occurred in 1941, when precipitation was deficient by 13 in., and the highest stage, early in 1943, was the result of excess precipitation in 1942. In contrast, the effect of ground-water withdrawals is exhibited in both of the observation wells in Lowell, a steady decline in water level, with a resultant loss of ground-water storage, having occurred since 1940. The sharp drop in water level in Lowell 41 is chiefly the result of the installation of a new large-diameter well within a short distance of the observation well. At present, the decline of water level in the Lowell wells appears to be tapering off, indicating that a new equilibrium level commensurate with the lowered rate of precipitation has perhaps been reached.

In the Woburn region, ground-water conditions are in general similar to those in the vicinity of Lowell, except that some of the bedrock wells show greater yields. As in Lowell, large supplies are available only in thick outwash deposits lying in buried valleys. A pre-glacial valley containing highly productive water-bearing material lies beneath the present course of the Aberjona River, which is shown in Figure 4. A tributary of this valley extends northwestwardly beneath Horn Pond. At its upper end, near Richardson's Pond, the valley is filled with about 80 ft. of outwash, but it deepens toward the south, and at the upper end of the Mystic Lakes it contains over 200 ft. of glacial deposits. The wells of the Wilmington Water Works penetrate about 80 ft. of outwash lying above the bedrock bottom of what appears to be another buried valley. Little is known of the extension of the valley, but its course appears to run generally in an east-west direction.

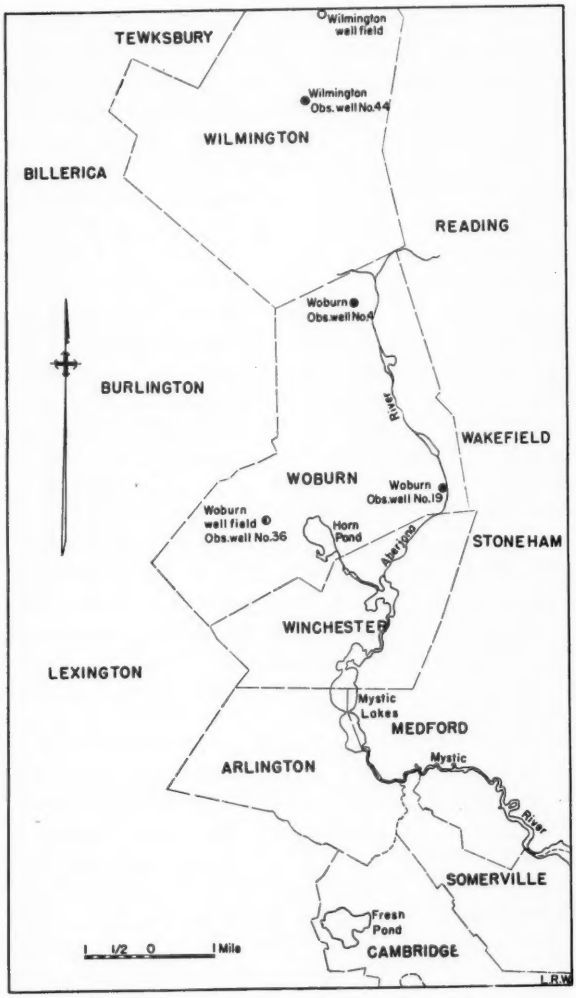

FIG. 4.—OBSERVATION WELLS AND PUBLIC GROUND-WATER SUPPLIES IN VICINITY OF WOBURN, MASSACHUSETTS

On the average, the ground-water pumpage in the Woburn area amounts to somewhat more than 7 mgd, about three-fourths being used for industrial purposes. The public supply for Woburn and part of the supply for Winchester are obtained from wells. The major part of the withdrawal is extracted from three pumping areas, the withdrawals being: (1) about 1.5 mgd in the vicinity of Horn Pond for the Woburn public supply, (2) about 2.5 mgd at several industrial plants lying along the Aberjona Valley, in the vicinity of the Woburn-Winchester boundary and (3) about 1.5 mgd for industrial purposes from the area just south of observation well Woburn 4.

Ground-water levels in observation wells in these three areas are shown in Figure 5. Also shown, for comparison, is the hydrograph

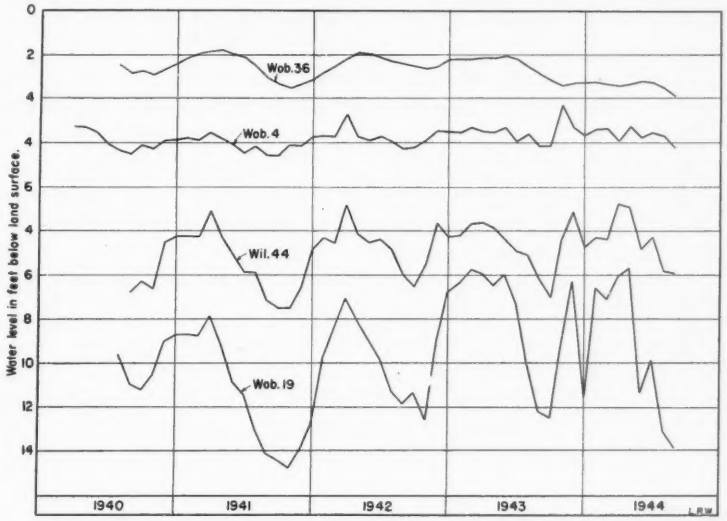

FIG. 5.—GROUND-WATER LEVELS IN VICINITY OF WOBURN, MASSACHUSETTS

for a well in Wilmington, which is remote from heavy pumpage. All these wells penetrate glacial gravels, and all except Wilmington 44 lie in the buried valley region. The pattern of the hydrographs in Figure 5 conforms fairly closely to the trend of precipitation during the past

five years, with major lows appearing in 1941, the year of lowest precipitation. The water levels in the Woburn observation wells are affected somewhat by ground-water withdrawals. However, the effect is not pronounced except in Woburn 36, and the cumulative loss in ground-water storage in the vicinity of the observation wells has been small even though abnormally dry conditions have prevailed for several years. At Woburn 36, an almost continuous decline of water level has occurred since the middle of 1943, the seasonal recovery at the end of that year being relatively small. However, the total decline is small in comparison with the total depth of water in the aquifer, and as yet it is not considered serious. In view of the factors involved, it seems likely that the water level will recover during the next upswing in precipitation.

During the spring of 1944, quantitative ground-water studies were begun by the Geological Survey in the vicinity of Fresh Pond in Cambridge. A number of test wells have been drilled by the Massachusetts Department of Health, and seismic surveys have been made to explore the geologic and ground-water conditions in the buried valley underlying the area. An intensive program of water-level measurements and other ground-water tests is under way. The work in the Fresh Pond area will extend the coverage of the field studies from Winchester down to the Charles River.

The water-level measurements made during the ground-water studies are published annually in the series of Water Supply papers of the U. S. Geological Survey. Reports on the other phases of the investigations are planned and may be released by either of the cooperating parties. In the meantime, the data that have been collected may be inspected by the public at the offices of the U. S. Geological Survey in Boston, Massachusetts, and Jamaica, New York.

PRACTICE OF DETERMINING SIZES OF SERVICE PIPES AND METERS

BY WALTER B. BUSHWAY*

[*Read September 20, 1944.*]

In determining the sizes of service pipes and meters, there are several factors which influence the water works superintendent:

1. Static pressure at the street main.
2. Set-back distance.
3. Number of tenants.
4. Air conditioning equipment, lawn and garden outlets, swimming pools, etc.
5. Flushometers.
6. Sprinkler and standpipe connections.
7. General use of premises.

Generally speaking, we are inclined to use the rule of thumb and to consider each application according to the information at hand.

Small Services. By and large, the 1-in. service pipe, cement lined, of wrought iron, with one ¾-in. tap and a ⅝-in. meter is the general practice for small single houses, two- and three-family houses, small shops, lunch rooms, drug stores, meat and grocery stores, barber shops, filling stations, etc. In the event that a six- or seven-room house is to have flushometers or has a set-back of 100 ft. or more, we lay a 1½-in. service pipe from the sidewalk stop to the meter and sometimes install a ¾-in. meter to provide for peak demands. The same procedure is followed with respect to two- and three-family houses with flushometers.

If the street pressure is under 14 psi we advise against the installation of flushometers. I understand that we may soon expect flushometers, made with a larger diaphragm, which will function satisfactorily at 10 psi.

The determination to install ⅝-in. meters is subject to change

*Superintendent Water Department, Brookline, Mass.

after a twelve months' period of service. We analyze all meter accounts annually and when a ⅝-in. meter is found to be registering in excess of 40,000 cu. ft. a year, it is replaced by a ¾-in. meter.

We do not furnish, read, service, or install secondary meters. In all cases, we furnish and lay pipe from the main to the meter and charge according to size as follows:

a. 1-in. service pipe: no charge for meter, or street work; 30 cents per foot from the street line to the meter in a trench prepared by owner.
b. 1½-in. service pipe: no charge for meter; $26.00 for street work; 50 cents per foot from the street line to the meter in a trench prepared by the owner.
c. 2-in. service pipe: no charge for the meter, $30.00 for street work, 75 cents per foot from the street line to the meter in a trench prepared by the owner.

This situation holds true whether the meter is placed in the building or in a meter box.

Larger Services. Service lines for larger apartment units, garages, groups of stores, laundries, large estates, and swimming pools are handled in the following manner:

1. Apartment houses of 6 to 18 families with or without flushometers are supplied by a 1½-in. service pipe, cement lined, with two ¾-in. taps at the main. These taps are connected to a Y yoke by ¾-in. tinned copped tubing, and the yoke is attached to a 1½-in. nipple, 6 in. long attached to a 1½-in. key cock. A ¾-in. meter is set for this service.

In the event that the static pressure is less than 20 psi or flushometers are installed, we make a third tap and connect the three goose necks to a triple manifold. Often we set a 1-in. meter to provide for peak demands or if there is an excessive demand.

2. Restaurants and garages of 30 or more cars which are serviced are as a rule provided with a 1½-in. service and two or three ¾-in. taps, depending on street pressures. A 1-in. meter is set.

3. Larger apartment houses of more than 18 but less than 30 are supplied by a 2-in. pipe, with two or three ¾-in. taps depending

on street pressures, and a 1½-in. disc meter or a ¾-in. by 2-in. compound meter is set.

4. Larger estates of 15,000, to 25,000 square feet of land with garden and lawn outlets, swimming pools, etc., are supplied by a 2-in. service with two or three taps depending on pressures. A ¾-in. by 2-in. compound meter or a 2-in. disc meter is set. If there is a set-back of 100 ft., we recommend that a 2-in. service from the main to a ground meter be placed at the street line and that from there on the owner install a 3-in. pipe, furnished and laid by his contractor. We do not carry the 3-in. pipe and limit our stock to 1-, 1½-, and 2-in. cement lined, wrought-iron, and 4-in. cast-iron pipe.

5. Swimming pools are generally furnished with a 2-in. line from two ¾-in. taps and a 2-in. meter. As a rule, it takes from 8 to 20 hours to fill a pool, depending on its size and the street pressure. A larger connection would have a tendency to upset the system locally and deliver roiled water.

6. Larger estates which comprise land in excess of 25,000 square feet with garden and lawn connections, swimming pools, sprinklers and fire standpipes, laundries, etc., also larger apartment units of more than 30 families, schools, public buildings, etc., require individual consideration and calculations based on pertinent data. With the exception of fire services, which are separate and not used for domestic consumption, these larger services are served through compound meters.

In order to prevent the overworking of our meters we generally follow the table listed below after our annual analyses have established the performance of individual meters.

METER PERFORMANCE MAXIMUMS PER ANNUM

Sizes of meter—in.		Maximum Annual Consumption Rates—cu. ft. per year		
⅝		40,000	overhaul at	200,000
¾		140,000	overhaul at	700,000
1		400,000	overhaul at	2,000,000
1½		800,000	overhaul at	4,000,000
2		1,400,000	overhaul at	7,000,000
⅝ x 2	compound	2,000,000	overhaul at	10,000,000
1 x 3	compound	3,000,000	overhaul at	15,000,000
1 x 4	compound	3,600,000	overhaul at	18,000,000
2 x 4	compound	annual check up		
2 x 6	compound	annual check up.		

Each service is therefore considered in the light of the foregoing, and there is sufficient latitude to provide adequate service.

We are inclined to deduct about 15 per cent from the demand figures furnished by the manufacturers of fire equipment installations.

We lay our own pipes from the main to the meter, whether or not the meter is located in the building or in a ground meter box. These ground meter boxes, by the way, are pre-cast concrete boxes with interlocking corners and are topped with a cast-iron square cover, 20 in. by 20 in. The meter boxes are sufficiently rugged to be used in street work although we prefer to build a brick manhole and to cover it with a circular cast-iron manhole cover, manufactured at State's Prison.

Revenue Increases. We have found that a systematic and regular inspection of our meter performances has paid the highest dividends. In water works, we consider our meters as a merchant would consider his cash register.

About eight years ago we concentrated on our meter accounts and the performance of the meters. This was done quarterly by our clerks when the bills were made out on the billing machines. At this time the clerks had before them consumption figures that covered a period of four years and any account which showed a sliding off was considered in the light of short changing. An inspection slip was made out and delivered to the Chief Inspector who in turn conducted an investigation. Meters were generally tested on the spot, the displacement being measured by the standard testing can, and any meters which under-registered or had been in service for more than ten years were snapped out and new or overhauled meters put back in their place. Meter readers, during their off reading periods, were sent out to seal all meters.

We have nearly 8,500 meters of all sizes in active service, and very soon the results of our control program became manifest. After a period of seven years we found that our revenues had increased from $286,000 to $406,000, a gain of 42 per cent. In addition to this procedure, our registrar continued to make his annual investigation of meter performances for the purpose of detecting overworked meters.

Four years ago we constructed a meter building which is complete and modern in every detail for testing, repairing, and storing

meters. This shop is a separate building and is closed to all employees of the department except the meter repair men and the Chief Inspector,—a very important practice. The meters are stored in a semi-humid basement, and we have had but little difficulty with dried up gaskets and packings.

One of four most valuable instruments is the meter master. It stops all arguments by the water takers.

All employees are required to listen for and to report leaks at any point in the system where they happen to be working, whether at a gate valve, stop cock, hydrant, or meter.

As a result of this program, with an increase of only 500 in population, we have been able to increase our revenue by 42 per cent and to hold down our annual consumption to the same level.

CHLORINATION—A FIVE-YEAR REVIEW

BY A. E. GRIFFIN*

[*Read September 20, 1944.*]

Chlorination turned a corner, according to at least one authority of national repute (1), in 1939. This assertion was prompted by data presented during the year showing that as chlorine is applied to water in increasing amounts the residual produced usually will increase following the first few additions, then decrease, and finally rise in proportion to the amounts of chlorine added. Subsequent research and plant practice have proved the accuracy of these original statements.

The basic data did not feature the fact that the residuals produced beyond the break-point, the point of lowest residual subsequent to the first appearance of a residual, consisted of free active chlorine. They did, however, point out that the water beyond the break-point contained very little, if any, free ammonia and that the majority of chlorine existing beyond that point was in an uncombined form. The real significance of this was not fully realized until Brown (2) at Ottumwa applied 110 ppm of chlorine to a water that consisted, due to a series of unusual conditions, of half sewage and half water. This "colossal" dose of chlorine used up nearly all of the free ammonia present, so that none remained to combine with the chlorine to form chloramines and only free available chlorine remained. This treatment produced a drinkable and safe water.

During the same year Calvert (3) proved in the laboratory that, when ammonia is present in water and chlorine is applied, the chlorine first reacts with the ammonia to form chloramines. He also pointed out that, when chlorine is added in excess of the amount required to combine with the free ammonia present to form chloramines, ammonia will be destroyed and the excess chlorine will remain as a free chlorine residual. These reactions were later confirmed by Griffin and Chamberlin (4) (5) (6). It thus became evident that the presence or

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absence of ammonia in water has a powerful influence on the reactions of chlorine in water and the results obtained.

To determine the point where chlorine alone was present, was at first very difficult. This was, however, greatly simplified by Laux (7) who demonstrated that whenever the full color is developed instantly following the application of ortho-tolidine to the sample, chlorine alone is present. This discovery placed the production and maintenance of free chlorine residuals on a practical basis. In fact, it later developed that by noting the proportion of color developed instantly and at the end of five minutes following the application of ortho-tolidine, the relative amount of chlorine and chloramine could be estimated.

Other tests soon followed including the Laux-Nickel (8) neutral ortho-tolidine test, the Keinath (9) methyl-orange test, the amperometric titration method of Marks and Glass (10), the Moore Test (11) utilizing p-aminodimethylaniline, and finally the Hallinan test (12) which is an amplification of the original Laux procedure. This test makes it possible for the average operator to differentiate between free chlorine and chloramines. Although not featured in the published articles, it should be noted that by the use of this test one is now able to estimate the amount of interference due to manganese, iron, and nitrites.

Coincident with this work, it was being demonstrated in the field that the maintenance of free residuals could be very effective from a bacteriological point of view as evidenced by the work of Wilson (13), Harvill, Morgan, Hagar, and Todd (14), McLaughlin and Haynes (15), Wardle (16), Smith and Lordley (17), and others.

At the same time, Weber, Bender, and Levine (18) showed that free residuals will kill spores within three minutes whereas chloramine residuals of the same magnitude may require up to 90 minutes. This was further confirmed by Streeter (19), who showed that coliform organisms can be killed within three minutes in the presence of free residuals as low as 0.05 ppm. He concluded, however, that in practice the residuals should be somewhat higher, possibly 0.10 ppm or 0.20 ppm, in order to insure a residual at all times.

Supplementing this work, Butterfield, Megregian, and Chambers (20) pointed out that (a) the time of exposure of bacteria to

free chlorine is a primary factor governing the extent of the bacterial kill; (b) hydrogenion concentrations has a marked effect on the bactericidal efficiency of free chlorine, the killing power diminishing with increasing pH values; (c) increase in temperature tends to increase the bactericidal properties of free chlorine. This knowledge should be very beneficial where extreme temperatures and pH values are encountered. One cannot expect, for instance, that the action of chlorine at a pH of 9.5 and a temperature of 39° F. would be as rapid as a similar residual at pH 7.0 and a temperature of 70° F.

The claim has often been made that waters will be made bacterially safe by the excess-lime method of water softening. This claim has been studied by Wattie and Chambers (21) who concluded at pH values between 9.51 and 10.0 the contact time must be greater than 6 hours to obtain a complete kill of the pathogens present but that at room temperatures and at pH values between 11.01 and 11.50 a 2-hour contact should be sufficient to obtain a complete kill. This means that temperatures, contact times, and pH values must be closely regulated where dependence is placed on this type of treatment for water sterilization.

Although most public health officials are primarily interested in the removal of coliforms and the common pathogenes, other investigators have concentrated upon the effect of chlorine upon the more obscure, possibly water-borne diseases such as tularemia and poliomyelitis. Foote (22) has reported that tularemia can be present in natural water and that water may be a connecting agency between infected animals and humans. His experiments, however, show that the maintenance of 0.2 ppm chlorine residual for a 30-minute period will kill *Pasteurella tularensis,* the causative agent. Krumbiegel (23) has pointed out that there is at present no epidemiological evidence that permits the belief that water is of any importance in the spread of poliomyelitis. Armstrong (24) has claimed that a residual of 4.0 ppm chlorine with a contact of 24 hours will inactivate the virus of poliomyelitis is slightly turbid, artificially contaminated water and that a residual of 0.4 ppm will suffice in clear water.

The chemistry of the reactions between chlorine and free ammonia in the concentrations ordinarily encountered in water works practice has continued to claim the attention of a few investigators.

Harvil and Morgan (14), for instance, claim that the ratio of chlorine to ammonia at the break-point is 7.6 to 1.0 whereas Moore (25) feels that the ratio is nearer 8.86 to 1.0. Both of these values are somewhat lower than the figure of approximately 10:1.0 reported by Griffin and Chamberlin (4). Rossum (26) prefers to believe that at the break-point mono- and di-chloramines react with each other. In view of these conflicting ideas, it is quite evident that the exact nature of these reactions is not competely known. Luckily, it is not highly important in practice that all of these minute details be revealed at once.

The reactions between chlorine and ortho-tolidine have been discussed by Griffin and Chamberlin (27), and their explanations have gone far to clear up many of the unknowns in relation to this important indicator. The cherry-red color for instance, so often connected with high chlorine residuals, cannot be depended upon for the estimation of any magnitude of residual. This is because the same color can be formed with residuals of 20 to 200 ppm or more. Furthermore, the ratio of ortho-tolidine to chlorine must always be greater than 3:1; otherwise "off-shades" will develop. Also, the acid content must be great enough to drop the pH of the sample to 1.3 or less. This is accomplished by using ortho-tolidine containing 150 ml of concentrated hydrochloric acid per liter. The constancy of the color produced is further stabilized by the use of 5 ml of ortho-tolidine per 100 ml of sample. These authors also called attention to the fact that, at pH values above 1.8, unstable meriquinones of variable color shades are formed. Since the reproduction of any single color in this range is dependent upon the amount of ortho-tolidine added and the pH of the sample, it was concluded that these colors could not be used directly for the quantitative estimation of chlorine. For the estimation of higher than normal residuals, 10.0 ppm or more, they proposed the use of a drop dilution method. In this method, ortho-tolidine is added to the diluting water, and the whole mixture is then brought up to the mark with the sample. The reading obtained by comparison with the regular standards, when multiplied by the dilution factor, represents the amount of residual chlorine in the original sample. Best results are obtained when the dilutions are such that the final chlorine content is well below 1.0

ppm. In this procedure, errors of dilution and chlorine demand are largely eliminated.

The relation between the spectrophotometric curves of orthotolidine colors and the colors of permanent standards (liquid) were studied by Chamberlin and Glass (28) (29). They showed that the produced ortho-tolidine colors and liquid standard colors are not perfect spectrophotometric matches but are so close that the ordinary eye cannot pick up the slight differences. Their researches further revealed that the Scott permanent chlorine standards could be somewhat improved by a slight change in the pH value of the final solution, by a slight change in the amount of chromate-dichromate used, and by dissolving these salts directly in the buffer solutions. The Control of Chlorination Committee (30) incorporated these findings in their 1943 report.

McCarthy (31) in his studies of the sterilizing activities of bromine and chlorine dioxide has come to the conclusion that neither agent is as effective as chlorine, but either could be used as a bactericide. Both agents are more affected by organic matter in water than is chlorine, and neither agent has nearly as much residual effect as chlorine.

Ammonia has been used in conjunction with chlorine to stabilize residuals and to prevent the production of chlorinous tastes and odors, particularly where the water has been polluted with phenols. This was a step in the right direction but has not given the complete answer, because every now and then the chloramine residuals have not persisted as they should have nor have they completely eliminated tastes and odors. Free residuals that are capable of completely satisfying the demand of water for chlorine offer another means for meeting these problems. Stable residuals consisting exclusively of free chlorine are reasonably easy to produce in waters devoid of industrial wastes. Where such wastes are present, however, this can be done only with difficulty as evidenced by Yaxley's (32) observations at Waterford, N. Y., where the demand, presumably due to industrial wastes in the Hudson River, increased progressively up to 100 ppm without any apparent stability point, particularly when various contact times were taken into consideration.

Water Works Chlorination Terms. These developments have led

to the rise of several new terms and to increased emphasis on some old terms associated with chlorination practices. Such nomenclature has been the natural outgrowth of plant practice and has been brought about by the necessity of differentiating between the results to be obtained and the point of chlorine application to obtain such results.

The Chlorine Committee (30) defines chlorine demand as follows:

"The chlorine demand of water is the difference between the amount of chlorine applied and the amount of residual chlorine remaining at the end of the contact period. The demand for any given water varies with the amount of chlorine applied, time of contact, and temperature. For comparative purposes, it is imperative that all conditions be stated. The smallest amount of residual chlorine considered at all significant is 0.1 ppm. Treatment of water beyond this point usually results in a series of increasing demands. Addition of that amount which will destroy the ammonia present is commonly termed 'break-point' chlorination. In practice, the ratio of chlorine to ammonia nitrogen (NH_3-N) at the break-point is seldom less than 10 to 1 and may reach 25 or more to 1."

Break-point chlorination is now recognized to be the production and maintenance of free chlorine residuals.

Superchlorination is the addition of chlorine beyond that needed to obtain an initial residual and without regard to the type of residual produced. Since the resulting residual is usually quite high, it must be lowered to a workable figure with a suitable dechlorinating agent. It thus follows that superchlorination and dechlorination are terms that are associated with each other.

With the rise of these specialized forms or types of chlorination, the term marginal chlorination has made its appearance. The term refers to the addition of sufficient chlorine to obtain an initial residual without regard to the type of residual formed.

The term chloramination has been in use for a considerable time and refers to the use of chlorine and ammonia for the formation of chloramines.

No new terms have appeared during the past few years relating to the point of chlorine application. The terms pre- and post-chlorination have been used for many years and generally relate to the position of chlorine addition in relation to the filters. Recently, however, there has been a tendency to accept post-chlorination as

meaning that the chlorine can be added ahead of the filters provided that chlorine has already been added previously in the plant.

Secondary chlorination is the addition of chlorine at one or more points in the distribution system subsequent to the purification plant. There has been some tendency to refer to this as relay chlorination, but this term has not received popular approval.

Plant Practice. The laboratory studies of chlorine and its reactions have had a profound effect on the application and use made of chlorine in plant practice. More and more, plants are carrying free chlorine residuals not only at the plant, but frequently through the system. This has led to an increased appreciation of chlorine as a tool in the purification of water.

Recent emphasis on the quality of water in the distribution system has led to the use of chlorine at distribution reservoirs for the control of both bacteria and algae. Such treatment is generally referred to as reservoir chlorination.

Immediately after Pearl Harbor, the U. S. Public Health Service made a recommendation that an adequate killing residual should be maintained in all water supplied to communities. The office of the Surgeon General of the Army issued a general order that a residual of 0.4 ppm should be maintained after 30 minutes of contact in the active water lines of army supplies. Impossible as it may have seemed, substantial residuals were produced and maintained at most army posts. Kessler (33) feels that such a schedule was very much worth while, for he has said that the maintenance of the much discussed 0.4 ppm residual has greatly reduced the number of non-potable samples of water examined at army posts. At Boonville, Mo. (40) gas-forming bacteria have been completely eliminated by the maintenance of free residuals throughout the distribution system of a strength up to 1½ ppm.

That maintenance of free residuals on top of filters has a value other than the mere killing of bacteria is evidenced by the experiences of Fuller (34) at Olean, N. Y., and Wilson (35) at Fredericksburg, Va., where the filter runs were greatly increased by such practice. In addition Fuller claims that active residuals oxidize iron and manganese so thoroughly that they can be easily removed on the filters. Such an effect appears to have great possibilities where iron and manganese prevail.

Jackson (36) has maintained pipe line capacity at Little Rock, Ark., by the production and maintenance of free residuals throughout the 30-mile length of the main conduit from the reservoir to the distribution system.

The claim has often been made that adequate cleaning of filters with chlorine will effectively remove mud balls and otherwise maintain the sand in excellent condition. Poston (37) of Ottumwa, during the current year, has written about his experiences of the past few years, and claims good results. Other places using routine filter chlorination include Denver, Colo., New Orleans, La., West Palm Beach, Fla., and Allentown, Pa.

At Baltimore, good results have been attained by maintaining what is known as a "Chlorine Blanket" a few feet below the surface of the Lake Ashburton Reservoir. For years, this reservoir had been subject to algal growth so that the water was turbid and tastes and odors frequently developed. By a rearrangement of piping, the application of chlorine was changed from the outlet, where it had been added for years, to the inlet. With a nominal application, chlorine residuals have been maintained throughout the reservoir, with the exception of the top few feet, with the result that all algae have disappeared. The water is now sparkling clear, and bacteria are never present.

Among the highly specialized uses of chlorine is the one reported by Hay (39) who claims that chlorine may be used to condition sodium silicate for use as a filter aid. This is accomplished by passing chlorine into a dilute solution of sodium silicate. The reactions form sodium hypochlorite and sodium chloride and liberate colloidal silica. In the process, the chlorine remains available as a sterilizing agent, sodium hypochlorite, and the silica becomes available as a silica sol coagulant aid.

Chlorine is useful for the removal of color from water either by direct bleaching or by combining with the various ingredients present. The former is usually a secondary effect of chlorination for sterilization and is more noticeable where facilities for coagulation and filtration are not available. At Boonville, Mo. (40) however, Bishop used chlorine, during the high-color periods of 1944, to assist coagulation, which in turn gave good color reductions. By way of comment he

says, "This is due to better coagulation of the water rather than to the bleaching effect of the chlorine."

Thus the literature of the past few years indicates that:

1) Proper control of chlorination will remove free ammonia from water and will leave a residual of free available chlorine.

2) Free available chlorine will eliminate practically all types of bacteria from water.

3) Temperature and pH of the water, together with exposure to and magnitude of the residuals have considerable bearing on the elimination of bacteria.

4) Destruction of coliform organisms at high pH values (about 11.0) requires considerable time.

5) Many new tests have been perfected to distinguish between chlorine and chloramine residuals.

6) An exceptionally good test has been developed to evaluate the extent of false residuals.

7) The reactions between chlorine and ammonia have been clarified.

8) The reactions between chlorine and ortho-tolidine have been explained.

9) The sterilizing velocity of other agents such as bromine and chlorine dioxide has been studied.

10) The proper conditions for the consistent evaluation of chlorine with ortho-tolidine have been established.

11) New chlorination terms have made their appearance; other terms have been clarified.

12) New uses for chlorine have been found, and old uses have been amplified.

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FINANCING NEW WATER SYSTEMS IN MASSACHUSETTS—PRESENT PRACTICE AND TRENDS

BY PAUL F. HOWARD*

[*Read September 20, 1944.*]

Although the present paper is confined to Massachusetts, it is hoped that the experience of various Massachusetts communities in financing new water systems will be of interest to communities outside of Massachusetts as well.

The General Laws of Massachusetts, as well as the usual special legislation, provide that a town or a water district may borrow money for the purpose of establishing a municipal water system by means of serial notes or bonds. These notes or bonds may extend over a period of thirty years or less; none of these notes or bonds need be repaid until the end of the third year from the time the notes or bonds are first issued. However, the payment for note or bond retirement in any year, beginning with the third year, may not be less than in any following year. The General Laws provide that a town may borrow up to ten per cent of its assessed valuation for the purpose of establishing a system; borrowing for this purpose by water and fire districts is generally provided for by special legislative acts and is usually limited to about ten per cent of the assessed valuation of the district.

In estimating the probable finances connected with a new water system, it is first necessary to estimate the total cost of constructing the system. When this has been done a table such as Table 1 can be set up.

It may readily be seen from this table that the uncertain item is the number of water takers. That is, how many of the houses, stores, etc., that will be adjacent to the proposed water mains will install services and use water from the new water system. The fewer the number of takers, the greater the sum that must be raised by taxation in order to secure enough income to meet expenditures

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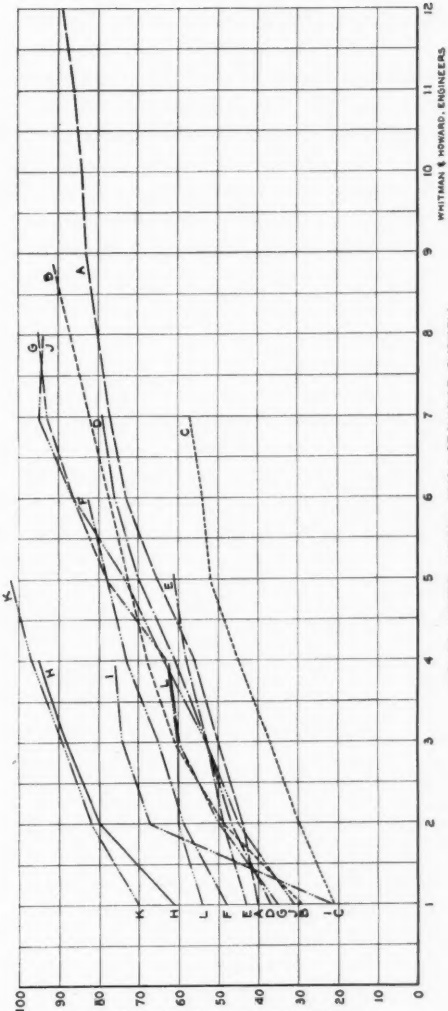
TABLE 1.—ESTIMATE OF PAYMENTS FOR BONDS, INTEREST, MAINTENANCE, OPERATION, ETC., FOR PROPOSED WATER SYSTEM FOR FIRST TEN YEARS

Year after first putting system into operation	Payment to retire serial notes	Interest payments at 2½%	Payments for Maintenance and Operation	Total estimated payments: Total of columns (2) to (4)	Estimated number of Takers	Income from Water rates at $24.00 per year	Additional Income from larger takers	Hydrant Rental raised by taxation	Total estimated income: total of columns (7) to (9)	Annual Deficit (—) or Surplus (+): Difference between columns (5) and (10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	0	7325	6000	13,325	450	10,800	1000	7500	19,300	+5975
2	0	7325	6000	13,325	500	12,000	1200	7500	20,700	+7375
3	11,000	7325	6000	24,325	550	13,200	1200	7500	21,900	—2425
4	11,000	7050	6000	24,050	600	14,400	1200	7500	23,100	— 950
5	11,000	6775	6500	24,275	650	15,600	1300	7500	24,400	+ 125
6	11,000	6500	6500	24,000	700	16,800	1300	7500	25,600	+1600
7	11,000	6225	6500	23,725	750	18,000	1300	7500	26,800	+3075
8	11,000	5950	6500	23,450	800	19,200	1400	7500	28,100	+4650
9	11,000	5675	7000	23,675	850	20,400	1400	7500	29,300	+5625
10	11,000	5400	7000	23,400	990	21,600	1400	7500	30,500	+7100

Net surplus 32,150 or provision for contingencies.

Note: This estimate contemplates that $293,000 will be borrowed by means of serial notes extending over a total period of 29 years, making 26 annual payments of $11,000 each and one of $7,000.

The only money to be raised by taxation is the hydrant rental payment of $7,500 per year which equals $1.50 on tax rate based on a valuation of $5,000,000.



PERCENTAGE INCREASE IN THE NUMBER OF WATER TAKERS FOLLOWING THE INSTALLATION OF WATER SYSTEMS.

to retire bonds, pay interest charges, and defray the cost of operation and maintenance.

A study of the experience of twelve water systems built in Massachusetts within the last thirteen years shows that the number of water takers at the end of the first year varied from 20 to 70 per cent of the total possible takers, and at the end of five years from 52 to 102 per cent. The accompanying graph shows the actual experience of these twelve communities in securing water takers. The percentage difference between the various systems is due to local factors that can be interpreted by one experienced in this field.

Table 2 shows interesting information in relation to the financial experience of these twelve communities with their new water systems:

System	Total possible water takers	Net cost per possible water taker	Interest Rate %	Average yearly payment out of taxation	Average increase in tax rate due to water system
A	250	$300	3½	———	———
B	250	400	3	$3,300	$2.00
C	790	180*	2	———	1.40
D	295	300*	3	3,300	1.25
E	980	540	av. 2.6	20,500	4.00
F	260	575	2½	5,600	3.00
G	450	260*	3¼	3,500	1.70
H	390	285*	1¼	3,600	0.65
I	360	550	2	4,200	1.90
J	450	275*	2⅞	5,200	1.95
K	720	400*	2¼	9,000	0.85
L	700	———	———	———	———

*Water system built with aid of grant or gift.

From Table 2, it may be seen that the increase in the tax rate in these municipalities due to installation of a water system has varied from 65¢ to $4.00 per $1,000 of assessed valuation. However, in sixteen Massachusetts water districts in the year 1942, the tax rate for municipal water works purposes varied from $1.60 to $9.50 per $1,000 of assessed valuation. It averaged $4.25 per $1,000 of assessed valuation, the medium rate was $4.00 per $1,000 of assessed valuation.

The net cost per possible taker of these twelve water systems varied from $180 to $550. By net cost is meant the total cost of

building the water system minus any grants or gifts. The systems that cost in the vicinity of $500 per possible water taker had a few takers who used great quantities of water and added substantially to the income of the respective water departments.

The rate of interest paid on the borrowed money is an important factor in considering the financing of a new water system. For instance, for each $100,000 of cost of a water system, one per cent in interest rate is equal to $1,000 or equal to the net income from about fifty water takers. Therefore, the lower the interest rate the fewer takers are needed successfully to finance the water system.

Never in Massachusetts has a municipal water system been abandoned. However, one system was built which was probably not justified. It added about $8 to $9 to an already high town tax rate. Great care should be taken that the building of a new water system is justified. In general, the building of a new water system will cut the fire insurance rates by about fifty per cent, so that in many communities the increase in tax rate is offset by the reduction in insurance rates. This reduction in insurance rates should be taken into consideration in determining the justification of the construction of a new water system.

GROUND WATER SUPPLIES—PRESENT PRACTICE AND TRENDS

BY DONALD E. STEARNS*

[*Read September 20, 1944.*]

Water which accumulates in the ground is termed ground water; its surface is the ground water level or water table. About 65 per cent of the public water supplies of the United States make use of ground water with collection principally through the installation of wells. In general, the larger cities depend almost entirely upon surface water supplies; cities below 25,000 population are about equally divided between surface and ground water supplies, while communities below 5,000 population depend on ground water supplies to the extent of nearly 70 per cent.

Ground water supplies, in general, have a high degree of reliability if not pumped beyond their safe yield. Natural ground water reservoirs provide large quantities of pure water. There is less danger of harmful bacteria being present in ground water supplies than in surface water supplies, provided that the ground water supplies are built in such a way that surface contamination is not admitted.

In ground water supplies, there is often evidence of undesirable characteristics such as excessive hardness, corrosiveness, and mineralization. Such water may need treatment to correct these objectionable features. Fortunately, the development of treatment facilities has kept pace with developments in methods of collection and distribution.

Present Means of Obtaining Ground Water Supplies. Ground water in New England is generally derived from formations of sand, gravel, and drift. Municipal ground water supplies are obtained from springs, infiltration galleries, and wells. The last includes dug wells, drilled wells, tubular driven wells, gravel-packed wells, and radial-process wells.

Spring supplies have been utilized, in the past, for limited re-

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quirements, usually where a gravity flow was possible. This was particularly true when pumping means had not been well developed and pumping costs were high. Generally, some form of collecting chamber was provided which protected the collected water from surface contamination.

Infiltration galleries, or filter galleries, resemble horizontal wells, built in a quite shallow water-bearing stratum to collect the underground flow and direct it to a chamber or sump from which it may be pumped either by suction or by a submerged pump. Safe yields may range from less than 100 gpm to well over 1,000 gpm.

Dug wells, or open wells, are generally large circular wells of reasonably shallow depth, say 15 to 35 ft. in diameter and 15 to 30 ft. deep, with either stone masonry, concrete masonry, or sheet-piling walls, to prevent surface water from entering. These wells have an unpaved bottom to permit inflow of water. The well tops are generally covered to prevent surface contamination. Sometimes, pipes are extended radially through the masonry near the well bottom to improve the inflow of water. Pumping from these wells may be by suction or by a submerged pump.

Drilled wells are generally sunk to a water-bearing formation at considerable depth from the surface. They may penetrate one or more impervious layers. A deep well is artesian if the water rises to a height above the adjacent ground water. Capacities may run from 5 gpm upward, depending upon type and size. An artesian well may make use of a submerged shallow-well pump or suction pumping. If the well is not artesian, a deep-well pump will probably be required.

Tubular driven wells consist of open-ended pipes driven into the ground and penetrating a water-bearing stratum. The lowest section of the well pipe is perforated with holes to permit the inflow of water through the side walls of the pipe as well as through the bottom opening. These wells generally are from 20 to 60 ft. in depth and 2½ in. in diameter, as used in New England. They may have a safe yield ranging from 5 up to about 35 gpm. Where the water-bearing stratum consists of fine material, a strainer may be needed at the bottom of the well to keep the material surrounding the screen from being drawn into the well. Pumping water from these wells is usually by suction.

Gravel-packed wells are wells built by sinking a casing to the bottom of the water-bearing stratum and removing the material from within the casing. A smaller well casing with a well screen attached at its lower end is then introduced within the first casing and the annular space between casings is filled with selected gravel or stone. The outer casing is then withdrawn, leaving a gravel wall between the well screen and the natural water-bearing stratum. In some cases, the well is surged as the outer casing is withdrawn in order to remove fine material from the water-bearing stratum and to develop the well by rearranging the remaining material. In other cases, the outer casing used is relatively large, and no attempt is made to develop the well by surging, but instead the material surrounding the gravel pack is intended to be left in an undisturbed condition. Gravel-packed wells have varying capacities depending upon the amount of development, the perviousness of the formation, and, of course, the water available from the location in question. Water may be derived from gravel-packed wells by a system of suction piping similar to that used for obtaining water from tubular driven wells, or by means of a deep-well pumping unit with its pump installed directly in the well and the pump impellers submerged, thus eliminating any need for maintaining vacuum during the pumping operation. Gravel-packed wells may range in depth from 25 ft. to more than 100 ft., with diameters ranging from 6 to 24 in. and yields from about 175 gpm to over 1,000 gpm.

Special adaptations of wells are numerous and varied. No attempt is made to enumerate them in this paper. Among these adaptations is the radial-process well which makes use of radial perforated well pipes to collect and conduct the water to a central, sealed reinforced-concrete caisson. Water is pumped from this caisson by any of the methods usually employed for ground water installations. The radial well pipes are flushed and backwashed to develop them in a manner similar to that used for vertical tubular wells. These wells seem particularly well suited to situations where demand is large, material is fine, and low velocities are necessary. Radial well pipes are forced into the water-bearing stratum by means of hydraulic jacks and may reach up to 300 ft. in length.

Cost of Ground Water Supplies. Costs of ground water installa-

tions are in wide variance because of the multiplicity of conditions that may prevail even for different installations of the same type. The figures presented herein give reasonable limits for certain types of ground water installations in New England, under average conditions. The predominating types of ground water installations in New England are tubular driven wells and gravel-packed wells.

Shallow tubular well installations will generally vary in cost from somewhat less than $20,000 to about $30,000 per million gallons yield per day. These costs include wells for explorations and test, the actual well tests, the permanent wells, and all permanent suction piping. The costs do not include pumping equipment.

Gravel-packed wells cost from about $10,000 to $15,000 per million gallons yield per day. These costs are exclusive of any pumping installations, pump house, or piping beyond the well. The prices include all items incident to the installation of the wells.

Installation costs for radial process wells are said to run from about $10,000 to $20,000 per million gallons yield per day provided that the capacity of the well is 25 million gallons per day or more. For smaller installations of less than one million dollars yield per day, the costs have run as high as five times the figures given.

Where conditions are favorable for an infiltration gallery, the cost to obtain water may be substantially less. Costs as low as $7,000 per million gallons yield per day may well be expected.

Advantages and Disadvantages of Common Types of Wells. Tubular driven wells have been in service in New England for about a century. In fact, there are examples of wells that are giving good service after 50 years of use. If the water is not corrosive and the wells are properly serviced, they should be good for 25 years or more.

This type of well is adapted to draw water from a water-bearing stratum of fine material by spreading out the wells at wide spacing over the area and pumping at low rates. In a stratum of fine material the use of tubular driven wells may involve relatively lower suction lift than the use of gravel-packed wells if low pumping rates, wide distribution of the wells, and relatively small draw-downs of water levels are adopted. Test wells of proven capacity may be utilized as a part of the well installation; a system of driven wells can be extended from time to time as the demand increases, thus permitting low capital

outlay at any one time. Tubular driven wells have reasonably long life and can be readily maintained since a single well may be serviced without discontinuance of pumping from the entire supply. Among the disadvantages of tubular driven wells are: inability to furnish water from a depth below the normal suction lift which may limit the yield, difficulty in maintaining suction pipe in well connections to prevent leaks, difficulty in maintaining wells so as not to damage them by overdraft when some wells decrease in yield, and danger of settlement from continued maintenance work which may cause air leaks in well connection pipes. This last named condition may become a serious maintenance problem in a large well field.

A gravel-packed well has the advantage of permitting concentrated production in such a way that an installation of one or more wells may produce the equivalent of many tubular wells. Wells of large capacity can be developed with minimum sizes of pipes since durable types of screens with high efficiencies have been introduced. Deep well turbine pumps can be installed directly at the well, eliminating the need for suction mains and making it possible with this type of pump to draw the water level down so as to procure the maximum safe yield of the well. Gravel-packed wells can often be developed to yield a given daily quantity at less cost than a system of tubular driven wells. Gravel-packed wells have much larger capacity per unit than tubular driven wells. Therefore failure of a unit is much more of a hazard to the total yield of the supply. Installation of gravel-packed wells in a tubular driven well field, the yield of which is fully developed will not increase the safe yield of the source of supply.

Trends in Use and Methods of Construction. In order to determine the trend in types of well construction, an effort was made to collect data on ground water supply installations in New England over a period covering the past 75 years. It has not been possible to secure complete data; however, the information collected partially covers five of the New England states—namely, Massachusetts, Rhode Island, Maine, New Hampshire, and Vermont—and is believed to indicate the trend.

There appears to have been no installation of gravel-packed wells in the five New England states prior to 1910, but since that year there have been 70 separate installations. During this same period,

there were 141 installations of tubular driven wells. A single installation may include one or more gravel-packed wells or several tubular wells. Since 1930, there have been 61 gravel-packed well installations as compared with 48 tubular well installations. Since 1940, these figures show 31 gravel-packed well installations and 16 tubular driven well installations. This would indicate that since 1930 there have been about five installations of gravel-packed wells to four installations of tubular driven wells, while the trend since 1940 has been about two installations of gravel-packed wells to one installation of tubular driven wells.

While the methods of installing tubular driven wells have been well established for many years, there have been marked advances in methods of determining the yield capacities of water-bearing strata and fluctuations in ground storage. This has made it possible to determine more accurately the safe yield of potential ground water supplies. In keeping with this advance, there have been developed types of wells more capable of utilizing the available water resources. This no doubt is one factor that has caused the gravel-packed well to gain in favor.

In general, the trend in developing ground water supplies appears to be as follows:

(1) To prove the existence and capacity of a new supply thoroughly and reliably by adequate explorations and tests before deciding upon a permanent installation.

(2) To limit the velocity of flow through the water-bearing formation so as to avoid clogging and damage, and thus prolong the useful life of the well.

(3) To stabilize thoroughly the water bearing formation by development operations or otherwise, to protect the useful life of the well.

(4) To procure the maximum safe yield available from the source by use of suitable pumping facilities to create the maximum safe drawdown of ground water level.

(5) To conserve municipal funds by developing that type of ground water supply which will afford greatest safe yield at lowest cost for construction, operation, and maintenance.

WATER FILTRATION—PRESENT PRACTICE AND TRENDS

BY E. SHERMAN CHASE*

[*Read September 20, 1944.*]

This paper presents a brief synopsis of present day practice in water filtration. In general, comparatively few developments have occurred since the paper the writer gave some thirteen years ago before the Institution of Water Engineers, a paper which was republished in the 1934 JOURNAL of this Association. Such developments as have occurred consist mainly of modifications of long established practice or refinements in details of design. Inasmuch as slow sand filters are now seldom built, and for small plants only, this paper will deal with filters of the rapid sand type.

Pretreatment. In the early days of filtration, the filter itself was all important. Today, the preparation of water for filtration and the devices and equipment required therefore are the features receiving attention at least equal to that given the filter. Pretreatment involves selecting and proportioning the proper chemicals for coagulation, the use of mechanical aids for hastening coagulation, and the installation in some cases of equipment for the mechanical cleaning of settling basins. Furthermore, much attention is given the design of basins, particularly with respect to inlets and outlets.

In plants where softening processes are involved, new types of settling basins have been developed in which the treated water passes through a sludge blanket, the function of which is to accelerate or hasten the chemical actions involved. In some installations, there is recirculation of the precipitated sludge.

At a few plants, notably in Milwaukee, two-story settling tanks have been used to conserve space. In general, however, settling tanks are designed as conventional single-story rectangular tanks.

With the adoption of activated carbon for taste and odor-control, aeration has become less necessary, and provision therefor has been omitted in some of the newer plants.

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Treatment Chemicals. Aluminum sulfate continues to be the standard coagulant, with lime or soda ash used when low alkalinity of the raw water requires. Occasionally, prechlorination is applied to facilitate coagulation and to destroy taste and odor-producing substances. Taste and odors are also controlled by activated carbon applied either before sedimentation or just ahead of the filters. Recently, the use of chlorine dioxide for taste and odor control has been receiving consideration and has been in use at Niagara Falls. Lime or soda ash continues to be used for adjustment of the pH of the filter effluent. Chlorine or chlorine ammonia are used for final disinfection. Ozone does not appear to be making much headway.

Filter Design. Except in industrial plants and for zeolite softening, pressure filters are used to a very limited extent. Most modern municipal filter plants are of the open, rapid gravity type. In general, filter design has shown few, if any, radical changes. Underdrains are of varied design, with the conventional perforated pipe grid being, perhaps, the most common. Tentative standard specifications for underdrain gravel and for filter sand have been prepared under the auspices of the American Water Works Association (see April, 1943 JOURNAL A.W.W.A.). In a number of plants "Anthrafilt" as a filtering medium has been employed, and its use appears to be increasing.

The tendency, so far as sand is concerned, is to use somewhat coarser material than in the past, in view of the dependence being placed on pretreatment and upon chlorination for final disinfection. High rate wash is generally used but with a tendency to provide supplementary agitation by Baylis surface wash jets or by the Palmer filter sweep. Air wash is comparatively little used in modern plants. It is interesting to note that the trend in filter washing, which for several years was away from supplementary agitation, is now towards such agitation. Wash water is provided either by means of elevated tanks or by wash water pumps drawing directly from the clear-water basin. The tendency seems to be toward the latter method. No radical changes have been made in filter plant accessories, such as rate controllers, loss of head gages, and similar equipment. Although the standard rate of filtration continues at 125 mgad, the exigencies of war demands have in some cases necessitated the operation of filter plants at rates considerably in excess thereof without apparent difficulty.

An interesting design for a filter plant for the removal of carbon dioxide and iron from a well supply at Provincetown, Massachusetts, is described by Paul Howard in the March, 1943 issue of this JOURNAL. This plant involves aeration, marble filters, secondary aeration, coke filters, and high-rate slow sand filters.

Filter Plants in New England. In 1942 the United States Public Health Service made a census of the water purification plants in the United States. This census was summarized in the February 10, 1943 issue of Water Works Engineering. The following tabulation shows certain interesting data relative to installations of filter plants in the six New England states:

WATER FILTRATION PLANTS IN NEW ENGLAND

(Data by U.S.P.H.S., published in *Water Works Engineering* Feb. 10, 1943)

State	Number of Municipalities	Estimated Population Served	Output Mgd
Rapid Sand Filters			
Connecticut	20	327,800	36.38
Maine	13	75,300	7.72
Massachusetts	9	292,700	26.38
New Hampshire	6	16,200	1.73
Rhode Island	8	567,800	45.14
Vermont	2	27,300	1.73
Total	58	1,313,100	119.08
Slow Sand Filters			
Connecticut	6	285,300	26.62
Maine	5	20,300	1.73
Massachusetts	17	378,300	33.20
New Hampshire	4	21,700	1.67
Rhode Island	0		
Vermont	1	6,600	1.50
Total	33	712,200	64.72
Grand Total	91	2,025,300	183.80

Objectives of Filtration in New England. The preceding table shows that approximately 25 per cent of the population of the New England States is supplied with filtered water. Unlike many sections of the country, New England depends to a limited extent only upon

badly polluted sources of water supply. Most New England supplies are either from good ground water sources or from ponds and impounding reservoirs providing water of reasonably safe and sanitary quality. Consequently, filtration practice here is largely for the purpose of reducing color and for removing taste and odors. Furthermore, filtration and its attendant processes provide means for turning out a water of uniformly satisfactory physical and sanitary quality year in and year out.

PUMPING STATION EQUIPMENT—PRESENT PRACTICE AND TRENDS

BY RALPH P. HALL*

[*Read September 19, 1944*]

During the past twenty years, many changes in pumping equipment for municipal water works have developed. Two of these are the type of equipment used, and the speed at which the equipment operates.

Previous to 1925, many municipal water works installations had in operation reciprocating equipment. Since 1925, most new plants have been built with centrifugal pumps. Also many old plants have been changed over. In shifting from reciprocating to the centrifugal pumps, a problem in priming was encountered due to the fact that centrifugal pumps will not handle any appreciable amount of air while pumping, whereas reciprocating or plunger-type pumps will do so without seriously affecting their operation.

Most of the pumping stations that have been built or changed over in the past twenty years, have followed the general pattern of installing one unit that did most of the work, usually an electric-, diesel-, or steam-driven centrifugal pumping unit, and a second unit that was considered a standby unit, usually driven by a gasoline engine. The priming system usually consisted of one electric- and one gasoline-engine-driven vacuum pump, together with other necessary appurtenances, such as vacuum tanks, air valves, and solenoid valves for the sealing of wet-type vacuum pumps.

Water works pumping stations are often placed close to the source of supply. Booster pumping stations are located where needed on the distribution system. In stations near the source, it is advisable to get the pumps themselves as close to the water as possible. If necessary, the pump should be placed in the basement of the station.

There has been a tendency on the part of some engineers in the past to make pumping stations quite small in size. New stations

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should be built large enough to accommodate additional equipment, to allow for growth of the system. The architecture of pumping stations, over the past few years, has changed in a great many ways. They are being made more attractive in appearance. In residential areas, some stations have been built to resemble residential dwellings. This is a wise procedure also where there is a chance of the community enveloping the pumping station in a residential district. Although such stations may cost more, the expense may be warranted.

Booster stations which are often built in residential areas are sometimes built underground. Usually a booster station is smaller than the main station because it does not need priming equipment. In gravel-packed wells the pump itself is inserted in the casing of the well, and the only equipment within the building above floor level is the driver of the pump. Such stations are usually quite small.

At Lynnfield Center, Mass., the pumping station contains duplicate units for pumping both water and air. The two main pumping units are driven on one side by an electric motor and on the other end by a gasoline engine. The priming system consists of two wet-type vacuum pumps which are likewise provided with dual drive. The electric control consists of duplicate starting equipment for each electric motor and is automatic. The pumps are started and stopped by pressure regulators which automatically control the level of water in the standpipe by the operation of the pumps. The control is totally enclosed. This is especially desirable when the operator is not a qualified electrician. The water for this station is obtained from driven wells 2½ in. in diameter.

During recent years many old steam stations have been revamped, removing the existing steam-pumping, plunger-type units and installing in their place electric-, diesel-, steam-turbine, or gasoline-engine-driven centrifugal units. The boilers have usually been abandoned or changed into low-pressure heating boilers, thus cutting out the expense of a licensed operating engineer.

Bath, Me., has removed one steam pumping unit and now uses the boilers for heating. Three large motor-driven centrifugal pumps and one gasoline-engine-driven standby unit have been installed.

At Calais, Me., the pumping station originally contained steam reciprocating high-head pumps, together with a steam-driven low-

head pump. This station takes its water direct from the St. Croix River which forms the boundary between the United States and Canada. Recently one of the high-head steam pumping units has been replaced by a dual electric-gasoline-engine-driven centrifugal pump, together with priming apparatus. The low-head pump has been fitted up with a gasoline-engine drive after removal of the steam engine. This station is a standby station. Water normally is purchased from St. Stephen across the Canadian border. Because of the chance of failure of the supply lines, it is necessary to keep the St. Croix River Station of the Calais Water Department on the American side in complete readiness at all times.

When the steam equipment was the only means of pumping, it was necessary to have an engineer on duty twenty-four hours a day. Now that they are equipped with electric- and gasoline-engine-driven units, several men in the Department are able to run this equipment. During the summer of 1944, the 12-in. main crossing the St. Croix River failed, and it was necessary to operate the gasoline-driven equipment in Calais for many days.

It has been stated many times that the diesel engine is the most efficient prime mover that has ever been devised, but this is only so if the engine is correctly chosen. Diesel engines ordinarily operate at a speed much lower than that of the pump they drive. This necessitates the use of gears, belts, or chain drives to increase the speed and is costly.

At Buzzards Bay, Mass., the equipment consisted of two diesel-driven pumping units, together with priming apparatus. The diesels operate at a speed of 1200 rpm and are directly connected to centrifugal pumps by means of flexible couplings. These engines were also equipped with generators that charge a bank of storage batteries which in turn supply lighting and power to operate the vacuum pump. This station has been in operation for six or seven years with a minimum of operating expense. Several other installations like this have been made in the past few years.

All of the pumping units mentioned so far have a pump speed of not over 1750 rpm. Pump manufacturers have offered for sale centrifugal pumps operating at no-load speeds of 3600 rpm for water works service. During the past ten years, a number of stations using

pumps at this speed have been put in service. As far as we know most of them have been successful. A talking point for pumps operating at the higher speed is that they are more efficient under some pumping conditions. They do present a problem in priming, however, as it is slightly more difficult to keep a pump properly primed at this speed. Examples of this type of equipment are found at Sturbridge, Mass., in a small pumping station where there are two units, one motor-driven and one gasoline-engine driven. The motor-driven pump has been in service for approximately ten years without giving trouble. The gasoline-engine standby unit operates at only 1800 rpm. Recently the town of Hudson, Mass., has placed in operation a new station, consisting of two high-speed units, both motor-driven.

Various methods of priming are used. Most of them, when properly set up and adjusted, give little trouble. The system most widely used consists of a horizontal or vertical combination sand-and-vacuum chamber in the suction line of the pump. The vacuum pumps evacuate the air from this tank and the entire suction system. They are controlled by the water level in this tank. Usually a float control is used, but recently a system of control for these vacuum pumps by means of electrodes has been used. These electrodes extend into the sand-and-vacuum chamber and, by means of a very sensitive relay, control the operation of the electric vacuum pumps.

Control of electric-driven units in pumping stations by pressure or water level in the standpipe or reservoir is employed when stations are intended to be entirely automatic in operation. Bourdon tube pressure regulators, as manufactured by the larger electrical companies, are used to control the operation of pumping units. These regulators have given much trouble. Almost perfect snubbing control of the pressure line feeding the regulator is needed. This was attempted by plunger-type or coil-type snubbers that did not always function correctly due to violent surges on the line.

More recently a regulator has been developed which operates like a bellows. This regulator is complete with stop and start adjustments. A time-delay feature of this new regulator makes it unnecessary to put a snubber in the line. The delay of two to three minutes before the starter is tripped allows the surges on the line to subside.

The adjustment of this regulator is done by means of two knobs on the top of the instrument itself, one of which controls the starting and the other the stopping of the unit. They are entirely separate from each other which makes the instrument simple to adjust.

The so-called self-priming centrifugal pump has not become popular in water works practice, because it is likely to be inefficient.

Pumping stations should always be equipped with measurement-of-flow devices.

PIPES FOR DISTRIBUTING SYSTEMS—PRESENT PRACTICE AND TRENDS

BY HERMAN G. DRESSER*

[*Read September 20, 1944.*]

When water works men think of pipes for distribution systems they think of three, or possibly four, types. These types in their order of manufacture in large quantities for water works purposes are as follows: cast iron, cement-lined wrought iron (now obsolete), asbestos cement, and steel.

The earliest use of cast-iron pipe was in Europe prior to 1700. The first pipes were crude affairs, not over 9 feet long with flanged joints which proved impractical due to rusting of bolts and failure to withstand settlement. The first real advance took place with the invention of bell and spigot joints in England about 1785.

An early competitor of cast iron was cement-lined wrought-iron pipe which consisted of an iron shell with cement lining ½-in. thick to form the waterway. Use of this wrought-iron pipe began in 1850 and was very popular in New England from 1880 to 1900. Breaks and leaks were not uncommon, and the life varied from 25 to 50 years. This experience did, however, establish the value of cement lining for maintaining carrying capacity. One of the principal post-war jobs of many New England cities will be the removal and replacement of cement-lined wrought-iron pipe.

Asbestos-cement pipe, first produced in Italy, was introduced into this country in 1927. It possessed distinct advantages, the principal one being absence from corrosion. It was also light in weight, easily handled, and was assembled by the use of flexible couplings. The use of flexible joints in conjunction with asbestos pipe undoubtedly stimulated the increased use of such joints for other types of pipe also.

The use of steel pipe in distribution systems had to await the arrival of methods for lining and coating steel to prevent corrosion.

*Principal Engineer with Thomas R. Camp, Consulting Engineer, Boston, Mass.

Although pipe made of steel plates covered with hot bitumen was used as early as 1851, large-scale use of steel pipe was just getting under way when the capacity of the rolling mills was required for war production. Steel pipe has the advantage of being rapidly laid in long lengths with flexible couplings. The material is elastic and can adjust itself to loads and settlement without breakage. The successful use of steel pipe, however, depends upon the ability of the manufacturer to provide protection against corrosion that will last for many years. Undoubtedly we shall hear more from the steel industry as soon as rolling capacity is again available.

As competing products appeared, the cast-iron pipe manufacturers were also improving their methods of manufacture. Pipe having cement or enamel linings became available. These linings helped to maintain carrying capacity far beyond the time experienced with plain pipe. All cast-iron pipe had been pit cast prior to 1922 when centrifugal casting was developed, and now spun pipe probably makes up more than one-half of the total production. The added advantages possessed by centrifugal pipe are greater density of metal resulting in thinner walls, longer lengths up to 20 ft., smoother surface of metal, and greater ability to withstand shock.

At an early date it was recognized by engineers that a life of 100 or more years for cast-iron pipe was not particularly impressive if the carrying capacity was reduced by one-half after 40 or 50 years due to tuberculation. Centrifugal methods offered the first satisfactory means of applying a thin cement lining to pipes, which would cause only slight reduction in the internal diameter, and would adhere firmly to the metal. After this method came into use, it enjoyed rapid growth. A recent improvement in cement linings is the application of a bituminous seal coat after the cement is dry. Spun bituminous lining was made available shortly after cement lining. It consisted of coal tar enamel containing a mineral filler, the filler being used to prevent sagging when the pipe was exposed to the sun. Considerable care and experience is required to produce pipe with spun bituminous lining that will be in perfect condition, free from sagging and blisters, when installed in the ground. It is my understanding that the principal difficulty is encountered when lining pit-cast pipe.

Until 1900, lead was almost universally used for jointing pur-

poses, but sulphur compounds began to be gradually accepted, and during the last twenty years these compounds have nearly displaced lead.

For years, there was little choice of kind of joint, but today many mechanical or compression type joints are available. Little was known about mechanical joints until 1932 when the Dresser Manufacturing Co. began a concerted effort to introduce them for water works use. Most water works men realize the advantages of mechanical joints. They permit the use of plain end pipe and assure absolute tightness in spite of strains, stresses, and settlement. Many types of these joints are available for new construction and for maintenance purposes. The "Bell Joint Clamp" is an interesting type which is now both simple and adjustable to all sizes of bell. It offers a means of protecting existing pipe joints against the danger of a blown-out joint where such an occurrence might result in serious consequences. The latest product is the "Bell Master" joint in which an assembled joint is placed within a special bell, and the gasket is compressed by means of cap screws.

Probably no one can predict the developments and new products that will become available for use in future distribution systems. However, with the developments that have taken place in treatment of metals to prevent corrosion it is not unlikely that in the future it will be possible to immunize the surface of cast-iron pipes against corrosion.

The field of plastics offers an opportunity for interesting speculation. Who knows but what some day pipes may be made of materials which are now unknown. It is not impossible to conceive of cast-iron pipe being lined with a material from the plastic industry, and if this material retains the properties often associated with it, namely flexibility, smoothness, and resistance to abrasion, it may prove to be the ideal pipe lining.

DESIGN AND CONSTRUCTION OF STANDPIPES AND ELEVATED TANKS FOR DISTRIBUTION SYSTEMS —PRESENT PRACTICE AND TRENDS

BY HOWARD E. BAILEY*

[*Read September 20, 1944.*]

Although World War II has curtailed the construction of standpipes and elevated tanks for municipal waterworks, new methods of construction and design introduced into the industrial field give promise of some sweeping changes in waterworks construction after the war. A brief résumé of the various components of standpipes and elevated tanks, and the trend in present day construction, follows.

Foundation. Standpipe foundations are much the same as those of twenty years ago. Crushed stone foundations were used for standpipes under special conditions up to fifty years ago. The hurricane of 1938 overturned a standpipe at East Brookfield, Massachusetts, which had a foundation laid up entirely of brick. Present practice indicates the use of a reinforced concrete slab and ring foundation where earth is encountered. Rock sites may be adapted for use by a broken stone cushion or by a plain or reinforced concrete mat. For sites partly on ledge and the remainder on rock fill a reinforced mat with thickened binding edge has been used. Concrete block foundations are required for elevated tanks. Concrete standpipes are supported on foundations of concrete in most cases.

Standpipe Materials. There were erected in New England some fifty years ago a number of wrought-iron standpipes when the cost differential between wrought-iron plate and steel was not so great as at the present time. Many of these standpipes have been replaced, due, not to the excess of corrosion of the plates, but to the straining of the rivets and to obsolescence. A number have capacities of only 100,000 gal., and the growth of the municipality with accompanying fire hazards has necessitated replacement of the old structure with a larger unit.

*Consulting Sanitary Engineer, Boston, Mass

Concrete standpipes with reinforced walls, poured by gravity, prior to the last war, have lost favor, and a new type of concrete standpipe with prestressed steel reinforcement is now being introduced. World War II has reduced the amount of steel available for reinforcing, and commercial steel wire is now being used at a considerable reduction in weight of metal. For this type of standpipe, the dome roof has been developed in a very thin section.

Steel standpipes and elevated tanks comprise by far the largest

FIG. 1.—PRESTRESSED WIRE WOUND CONCRETE STANDPIPE, MIAMI, FLA.

FIG. 2.—CATHODIC PROTECTION—80-FOOT STEEL STANDPIPE WITH 65-FOOT STAINLESS STEEL ELECTRODE, SHIRLEY, MASS.

number of structures for storing water for municipalities where storage above ground is required. In standpipes, welded construction has taken precedence over riveting. In elevated tanks, however, of small capacity, the riveted construction is cheaper than welding A new technique has been introduced in welding, using higher amperage and special rods. This reduces the time of construction considerably.

Prestressed Concrete Standpipes. The system of constructing concrete standpipes and prestressing the reinforcing by the use of turnbuckles has been in use for some time. During World War II, however, the shortage of steel reinforcement and other factors have fostered the development of spirally bound standpipes, using high tensile wire. The construction involves forming with the cement gun, the cylindrical shell in which are embedded vertical reinforcing rods, capable of being prestressed. The shell is then bound by a wire wound by a newly developed machine riding on the roof of the standpipe, capable of spirally binding the standpipe under any given predetermined wire stress.

FIG. 3.—RADIAL CONE BOTTOM ELEVATED TANK OF 1.5 MG. CAPACITY, INDIANAPOLIS, IND.

At the present time, the practice is to place the wire with an initial stress of 150,000 psi, which, after allowing for shrinkage and plastic flow, permits the use of a working stress in excess of 100,000 psi. Three of the most recent wire-wound water storage tanks were completed last year for the city of New London, Conn. The total capacity of the three tanks was 5 mg.

The wire winding is also being used as a method of repairing and restressing steel-reinforced structures that, due to shrinkage of the concrete, have lost the original prestress. Savings in the use of the wire-wound prestressed construction result in a reduction in steel over the conventional reinforced concrete design of approximately 10 to 1.

Riveted versus Welded Steel Standpipes. Welded steel construction is used almost exclusively for standpipes except in those areas where welding is not permitted due to danger of fire to adjacent structures. During the past ten years, approximately forty-five welded standpipes have been built for municipal water works in New England territory. During this same time, only about three welded elevated tanks and towers have been built. Current practice indicates that welding has preference on elevated tanks having capacities over 500,000 gal., while for tanks of smaller capacity riveting still works out a little more economically, due largely to the fact that the assembling of a welded elevated tank is more difficult than of a riveted one.

Welding. During World War II there has been developed a new arc-welding technique, using the "arc force," or digging power of the welding arc to obtain faster welding speeds and lower welding costs. Currents as high as 450 amperes are used, and less passes are required to complete the joint. For the thin plates, up to $\frac{3}{8}$ in., butt welding can be used without beveling the edges of the plate. For $\frac{5}{8}$-in. plate, about 350 amperes are used, with a linear speed almost three times that of standard welding. It would appear that this development will reduce the cost of municipal standpipes in the future and at the same time permit much faster erection.

Preparation of Steel Plates. Sandblasting has long been the customary high grade method of cleaning the mill scale from plates for painting. In recent years, however, pickling of the plates with

sulfuric acid with phosphoric acid as an inhibitor has been used. This method has worked out satisfactorily and results in some saving in cost over sandblasting.

More recently, a system of flame cleaning has been developed, using a multiple gas flame to remove mill scale or paint. Since the

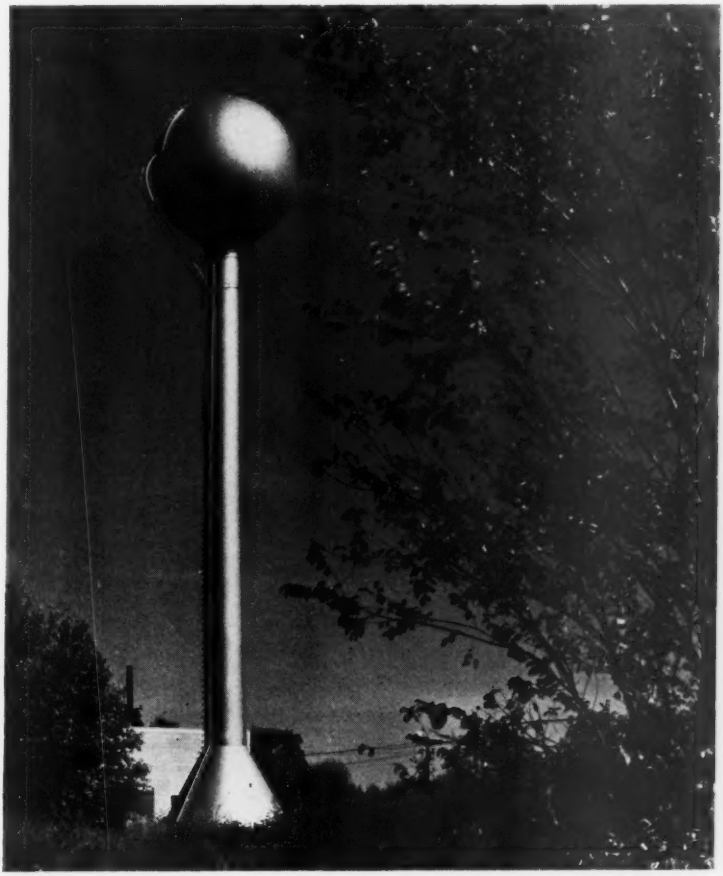

FIG. 4.—SPHERICAL ELEVATED TANK, 100 FEET TO BOTTOM, COWDEN, ILL.

surface must be wire-brushed after the flaming, the cost of this treatment equals, or exceeds, the customary wire-brushing method.

The introduction of cathodic protection against corrosion for the inside of standpipes has obviated the necessity of painting the interior of new standpipes.

Painting Materials. Up until a few years ago, it was customary to apply three coats of red lead and linseed oil to the exterior and interior of standpipes. Litharge was added to the interior coat as a hardener. The exterior coats were tinted various colors to secure complete coverage. The favorite exterior color appeared to be a dark green, although black standpipes and elevated tanks were common fifteen to twenty years ago. Other paints ranging from a leaf or jade green to a sandy concrete color have been used. The green paints have a tendency to fade.

Within the last ten years, basic lead chromate with synthetic

FIG. 5.—SPHEROIDAL TANK, 90 FEET IN DIAMETER AND 47 FEET HIGH, BROOKLINE, MASS.

resin varnish has been used, with good success, for the interior of the standpipe, and for the first shop coat of the exterior. Two coats of aluminum paint are then sprayed on to form the finish of the exterior surface. The aluminum paint lowers the visibility of the standpipe when silhouetted against the sky. On the whole, it would appear that the aluminum coating is the most satisfactory one to date. During the war, aluminum has not been available for painting, and many of

FIG. 6.—STREAMLINED STEEL STANDPIPE OF 2.5 MG. CAPACITY, TULSA, OKLA.

the municipal tanks have been left without renewing the exterior paint for a number of years.

Electrolytic Protection against Corrosion. Since 1939, this equipment has been installed in over fifty standpipes and elevated tanks used in water supply systems of municipal water works and institutions in New England, not including industrial plants. This method of introducing a small amount of direct electric current into the water in the tank, by using one or more electrodes suspended from the roof as one pole, and the shell of the tank as the other pole, to resist corrosion, has been steadily gaining favor. Originally, carbon electrodes were used. They were replaced by stainless steel electrodes, and more recently by choke coils.

A five-year record of performance indicates that the cathodic method of protection against corrosion is successful in combating this trouble. Observations of the walls of tanks after drawing down the water level indicate the walls to be smooth with a slight film covering the clean metal. The apparatus may be used in old tanks without cleaning the walls. After a period of sloughing-off of old paint, the cleaned surface is exposed. The use of cathodic protection obviates the necessity of drawing down the tank and keeping it out of service for a number of days for interior painting. It also saves the cost of removing the rust and scale from the interior by the use of chisels and wire brushes.

A surprisingly large number of tanks in New England, in which electrodes have been installed, have experienced no trouble from ice. In a few cases, the electrodes have been bent during the winter, due to ice, and are being removed during the winter season. The use of choke coils is relatively recent, and no considerable volume of operational data is available.

Recently, at least one firm has offered a service policy whereby for approximately ten per cent of the cost of the apparatus yearly it will service the equipment, furnishing all necessary repairs and replacements and keeping it in working order.

Appurtenances. Inside ladders are impractical in New England weather. Outside ladders are sometimes protected with guards but many are without safety devices. Entrance manholes are specified larger than those for boiler inspection or pressure work. Copper-

bearing steel is being used in the roofs of standpipes and elevated tanks but may be eliminated from the tanks where welded construction makes practicable the use of an ellipsoidal top.

Blow-off and mud valves in the bottom of elevated tank risers are being eliminated. Blow-offs are often provided from a T connection in the valve chamber between the standpipe outlet and the main control valve. The use of check and altitude valves in the standpipe connection are common, the check valve allowing the full draft from the standpipe but closing so as to force the inflow to the standpipe through an altitude valve placed in the bypass. Considerable difficulty is still experienced with altitude valves where the ratio between the draw-down and the height of the standpipe is only a few per cent.

The use of telemetering apparatus for long distance indication of water levels and for starting and stopping pumps supplying the standpipes is becoming common.

Shapes. An attempt has been made in recent years to streamline water works storage structures. Concrete standpipes have been built with rings, flukes, and other decorations. The welded construction of steel standpipes has improved their appearance. Balconies at the top of the standpipe are no longer in common use. A radical change has been made in the design of at least one water works standpipe, using the spheroidal shape. Although this shape has become common for oil storage and at synthetic rubber plants, the tank at Brookline is the only one that is so far used for water storage in New England.

Changes in elevated tank outline include the use of the radial cone bottom for large elevated tanks. This permits an overhang of the tank beyond the circle of the tower, giving a mushroom appearance to the structure.

The use of welding in elevated tank construction has allowed the side plates to be extended up to form an ellipsoidal roof, replacing the conical roof of previous construction. Various freak shapes, such as pineapples and bottles, have appeared as advertisements but are not in common use for municipal water works. There are a few spherical tanks, supported on a cylindrical tower, constructed of steel plates instead of the usual post and lattice work.

Conclusions. The most important trends in construction of standpipes and elevated tanks are:

1. The use of prestressed wire and spiral winding for concrete tanks.
2. Improved techniques in welding that will allow more rapid construction of welded tanks at lower cost.
3. Changes in the shape of the enclosing structure to meet hydraulic conditions and new methods of assembly.

PROCEEDINGS

Sixty-Third Annual Convention

Poland Spring, Maine

September 19 to 22, 1944

This is a synopsis of those parts of the proceedings of the Sixty-third Annual Convention that appear to be of value for the record.

The Sixty-third Annual Meeting of the New England Water Works Association was held at the Poland Spring House, Poland Spring, Maine, on September 19 to 22, 1944.

Tuesday, September 19

Morning Session

President Horace L. Clark called the convention to order.

Administrative and Committee Reports

The Annual Reports of the Secretary, Treasurer, Editor, and Finance Committee were presented, accepted, and ordered placed on file (see p. 376).

The Annual Reports of the Committee on Committees, the Legislative Committee, Committee on Reciprocal Relations with the Institution of Water Engineers, Committee on War Time Activities, and Committee on Library were presented, accepted, and ordered placed on file (see p. 391).

Progress Reports were presented by the Committee on Specifications for Cast Iron Pipe and Special Castings, the Committee on Hydrant Specifications, and the Committee on Water Works activities.

Closing of Polls and Appointment of Tellers

The President declared the polls closed and appointed the following tellers: William P. Melley, Roger G. Oakman, and Stephen H. Taylor.

Luncheon Session

The Association was welcomed to Maine by Frank E. Southard, Chairman of the Public Utilities Commission of Maine.

Award of Dexter Brackett Memorial Medal

Roger G. Oakham. Mr. James A. Newlands, Chairman of the Committee on the Award of the Dexter Brackett Memorial Medal, regrets that he could not be here. As a member of the Committee I will read the Report of the Committee:

Mr. President, members and guests of the New England Water Works Association: It is the very pleasant duty of the Committee on the Award of the Dexter Brackett Memorial Medal to designate the author of the most meritorious paper, based on its applicability to general water works problems and published during the past year.

Your Committee, consisting of M. G. Mansfield, Roger G. Oakham and myself, has carefully examined all of the excellent competitive publications.

We have agreed that there were two outstanding papers in the group, and we propose for honorable mention the article on Viability of Bacteria in the Presence of Phosphates by G. A. McCarthy and W. E. Cassidy.

It was the unanimous opinion of the Committee that the most meritorious paper was that of Thomas R. Camp on Hydraulics of Distribution Systems, published in Volume 57 of the Journal for the calendar year of 1943.

Mr. Camp, it gives me a great deal of pleasure to present you as the medalist. Due to inadvertent circumstances, however, the medal is not here, but it will be forthcoming, it is on its way, and so at this time I will give you the outside covering and wrapping as a token of its ultimate arrival.

Thomas R. Camp. *Mr. Oakman, Mr. President, Mr. Southard, members, ladies and gentlemen:* I had been forewarned about the missing medal, but I was not prepared to read the inscription on the box, which says, "Do not open until Christmas."

I was very much surprised when I received the notice of this award. I really never considered the paper as being worthy of the award, and I think the Committee was somewhat generous in giving it to me.

The Dexter Brackett Award appears to be the only one given by the New England Water Works Association. I have read the list of those who have been fortunate enough to receive it in the past,

and it is a very notable list. I am very happy to have my name added to it, and I hope it will not be a discredit to the list. I thank you.

New Members

Secretary GIFFORD announced the election of the following to membership in the Association:

Members: Maurice Lymann Brashears, Jr., Geologist in charge of Ground Water Investigations, New York and New England, for U. S. Geological Survey, St. Albans, N. Y.; Patrick Bernard Bresnahan, Water Commissioner, Holyoke, Mass.; Walter Clyde Campbell, Superintendent, Water Works, Dover, N. H.; Mayo Carrington, Sanitary Engineer, Massachusetts Department of Public Health, Worcester, Mass.; John J. Callahan, Superintendent, Pumping Station, Avon, Mass.; Martin F. Finnegan, Manager and Treasurer, Stockbridge Water Co., Stockbridge, Mass.; Edward J. Murphy, Registrar, Water Works, Holyoke, Mass.; Clayton Eugene Osborn, Public Works, Portsmouth, N. H.; Howard George Marsden, Secretary, Treasurer, and Manager, Manchester Water Co., Manchester Center, Vt.; Charles Germane Richardson, Vice-president, Builders-Providence, Inc., Providence, R. I.; Harold James Stewart, Assistant to Superintendent, Water Department, Portsmouth, N. H.; Theodore Ernst Veltfort, Manager, Copper and Brass Research Association, New York, N. Y.; Michael B. Oates (reinstated), Superintendent, Water Department, Watertown, Mass.

Corporate Member: Board of Public Works, Gardner, Mass.

Associate Member: Royer Foundry & Machine Co., Kingston, Pa.

The PRESIDENT. I have the pleasure to announce that at the Executive Committee meeting last evening Arthur D. Weston, Chief Engineer of the Massachusetts Department of Public Health and a Past President of this Association, was elected to honorary membership. Mr. Weston is marooned in Edgartown and has sent the following telegram: "I deeply appreciate the honor of honorary membership and will always cherish it and try to keep myself worthy. Best wishes to you all."

Afternoon Session

A paper "Notes on Water Supply in the North African Cam-

paign," was read by William E. Stanley, Professor of Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass. E. A. Sigworth, A. E. Griffin, and E. Sherman Chase took part in the discussion.

A paper "Laws Governing Water Utilities," was read by David E. Moulton, Attorney, Portland Water District, Portland, Me. Frank J. Gifford, Paul F. Howard, Harold W. Griswold and Herman G. Dresser took part in the discussion.

A paper "Ground-Water Studies in Northeastern Massachusetts," prepared by M. D. Brashears, Jr., and C. M. Roberts, United States Department of the Interior, Geological Survey, was read by Mr. Brashears. William W. Brush, Joseph C. Knox, and William P. Melley participated in the discussion.

WEDNESDAY, SEPTEMBER 20

Morning Session

This session was devoted to a symposium on Present Practice and Trends in the Water Works Field. The following papers were presented:

"Ground Water Supplies" by Donald E. Stearns, Civil Engineer, Boston, Mass.

"Filtration" by E. Sherman Chase, Metcalf & Eddy, Boston, Mass.

"Chlorination" by A. E. Griffin, Technical Service Division, Wallace & Tiernan Co., Inc., N. J.

"Piping for Distribution Systems" by Herman G. Dresser, Boston, Mass.

"Pumping Stations" by Ralph P. Hall, Inc., Boston, Mass.

"Standpipes and Elevated Tanks for Distribution Systems" by Howard E. Bailey, Boston, Mass.

"Financing New Water Systems and Extensions in Massachusetts" by Paul F. Howard, Whitman & Howard, Boston, Mass.

"Office Practice, Billing and Collecting" by Roger W. Esty, Superintendent, Danvers Water Works, Danvers, Mass.

The discussion of these papers was participated in by Roswell M. Roper, Ralph P. Hall, Howard E. Bailey, Arthur L. Shaw, President Clark, and William W. Brush.

THURSDAY, SEPTEMBER 21

Morning Session

A paper "Fall River Industrial Water Supply," was read by John L. Hayden of Hayden, Harding & Buchanan, Boston, Mass. Frank J. Gifford, Arthur L. Shaw, William W. Brush, Percy A. Shaw and Linn H. Enslow participated in the discussion.

A paper "Design of an Army Ordnance Water Supply," was read by Truman H. Safford, Hydraulic Engineer, Charles T. Main, Inc., Boston, Mass.

A paper "Submarine Water Mains Built in Deep Water," was read by James R. Gardner, Office of Regional Director, Federal Works Agency, Portland, Me. The paper was discussed by E. Sherman Chase.

Afternoon Session

A paper "Changing Trends and Their Effect on Water Utilities," was read by Arthur E. Gorman, Director Water Division, Office of War Utilities, Washington, D. C. Roger W. Esty, President Clark, and William W. Brush took part in the discussion.

A paper "Sodium Chlorite—A New Development in the Treatment of Potable Water," prepared by John F. Synan, G. P. Vincent and J. D. MacMahon, of The Mathieson Alkali Works, Inc., New York, N. Y., was read by Mr. Synan. Stuart E. Coburn, Linn H. Enslow, Harold L. Griswold, and Stanley M. Dore took part in the discussion.

A paper "Diatomaceous Earth Filtration," illustrated by a colored movie film, was read by H. E. Hollberg, Vice-President, Proportioneers, Inc., Providence, R. I. William W. Brush and Stuart E. Coburn took part in the discussion.

A paper "Water Disinfecting Tablets," prepared by Gordon M. Fair and Associates, Harvard Graduate School of Engineering, Cambridge, Mass., was read by Professor Fair. The discussion was participated in by Percy A. Shaw, Stuart E. Coburn, Stanley M. Dore, Linn H. Enslow, and President Clark.

FRIDAY, SEPTEMBER 22

President Clark presented twenty-five-year certificates to the following members: Henry F. Beal, Waltham, Mass.; Gustavus H.

Bean, Derry, N. H.; Benjamin E. Fox, West Springfield, Mass.; Timothy W. Good, Cambridge, Mass.; Scotland G. Highland, Clarksburg, W. V.; Joseph A. Hoy, Worcester, Mass.; Walter H. McMahon, Chelmsford, Mass.; Morrison Merrill, Wakefield, Mass.; Leroy M. Peterson, Duxbury, Mass.; A. B. Thompson, Waterville, Me.; Milton Thorne, Portland, Me.; and Roswell M. Roper, East Orange, N. J.

These awards are made to water works superintendents, registrars and commissioners who have served the same municipality for twenty-five years or more, or who have been members of the New England Water Works Association for at least that number of years. The employees of the private water companies are not included in this award.

A paper "Studies of Water Distribution Systems," was read by Roger G. Oakman, Superintendent, Water Division, Public Works Department, Needham, Mass. Horace L. Clark, Donald C. Calderwood, William W. Brush, David E. Moulton, William J. C. Marshall, William P. Melley, Harold W. Griswold, Bayard F. Snow, Roger W. Esty, Lloyd Nelson, F. J. Callahan and Richard H. Ellis took part in the discussion.

A paper "Annuities for Public Service Employees," was read by F. J. Reny, Treasurer and General Manager, Portland Water District, Portland, Me. Roger G. Oakman and Harold W. Griswold discussed the paper.

A paper "Building Services and Meters," was read by Walter B. Bushway, Superintendent, Brookline Water Department, Brookline, Mass. David E. Moulton, Donald C. Calderwood, William W. Brush and Roger W. Esty took part in the discussion.

The Proposed Revision of Hydrant Specifications was discussed by Roger W. Esty, W. B. Bushway, F. J. Gifford, Donald C. Calderwood, Harry W. Fuller, William W. Brush, President Clark and Harold W. Griswold.

Report of Tellers of Election

To the Members of the New England Water Works Association:

The Tellers appointed to count ballots for the election of officers report the result of voting as follows:

For President: Karl R. Kennison .... 260 votes, 1 blank
For Vice-President: Arthur L. Shaw .. 258 votes, 3 blanks
For Director: Samuel M. Ellsworth .. 252 votes, 9 blanks
For Treasurer: Frank J. Gifford .... 257 votes, 4 blanks
Total votes cast 261

(Signed) WILLIAM P. MELLEY
ROGER G. OAKMAN
STEPHEN H. TAYLOR

The PRESIDENT. I hereby declare these men elected.

The death of Mr. Samuel Ellsworth has brought about a regretful situation. The ballots had gone out prior to his death, and the by-laws are not very exact covering a case of that kind. I now declare the office of Director vacant, as Mr. Ellsworth, unfortunately, is unable to fill it.

We sent out another ballot, after requesting the Nominating Committee to furnish another name, and while we were unable to fulfill the time allowance we felt that this would be a guide to the Executive Committee in filling the vacancy caused by Mr. Ellsworth's death. Will you give us the report on the secondary ballot.

WILLIAM P. MELLEY. In the special election to fill the office of Director vacated by the death of Samuel M. Ellsworth, the result was:

"For Director: Sidney S. Anthony .... 181 votes, 0 blanks.

"We respectfully suggest that the Executive Committee consider a change in the by-laws to provide that in future elections the inner envelopes used in balloting be omitted or furnished with ungummed flaps to make the work of the tellers easier."

Respectfully submitted,
WILLIAM P. MELLEY
ROGER G. OAKMAN
STEPHEN H. TAYLOR

The PRESIDENT. Mr. Anthony's election will be confirmed by the Executive Committee.

Presidential Address

By Horace L. Clark, Retiring President

This meeting brings to a close my term of office as President and Acting President of the New England Water Works Association. During the two years in which I have served, our country has been engaged in the greatest war that the world has ever known. We have seen a change from the danger of enemy attack on our own shores to the entry of our troops into Germany. This change has meant the largest production program which ever faced the nation, and it has in turn placed an unprecedented load on the water works industry, which has been met despite shortages of labor and restrictions on material in the quiet and efficient way of the water works personnel. I have heard of no Army and Navy E's being presented to any water works but I think these awards would be well deserved in many cases.

During this past year the emphasis has been largely on post-war planning, and the recent easing of restrictions by the War Production Board indicates that the time is drawing near to put these plans into effect and give such employment as is possible to our returning veterans.

The matter of supplying the armed forces with water has led to the construction and operation of many plants, and there will be quite a fund of data derived from these experiences which I think should be accumulated and digested by the Water Works Association.

I wish to express my sincere thanks to the members of the Executive Committee, the Secretary, Mr. Frank Gifford, the Assistant Secretary, Mrs. Mildred Locke, the Editor of the JOURNAL, Professor Gordon M. Fair, and to Mr. Joseph Knox, the efficient chairman of the Program Committee, for their assistance during my term of office, and in behalf of the Association I wish to express my appreciation also to the Water and Sewage Works Manufacturers Association, Inc.

It is now my pleasure to present your new President, Mr. Karl R. Kennison, Chief Engineer of the Metropolitan District Water Supply Commission. Mr. Kennison, I wish to congratulate you upon your election to the presidency of the New England Water Works

Association. It gives me pleasure to hand you this gavel and to know that the association is entrusted to such good hands.

MR. KENNISON. I deeply appreciate this honor of becoming president of an organization of this sort, which is about the finest I know of. I know you have all had a wonderful time here and want to get home, so that I will not make a speech. I think a motion to adjourn will be in order.

On motion, duly seconded, it was VOTED to adjourn.

ANNUAL REPORT OF THE SECRETARY

Mr. President and Gentlemen of the New England Water Works Association: The Secretary submits herewith the following report of the changes of membership during the past fiscal year, and the general condition of the Association.

The present membership is 800, constituted as follows: 9 Honorary Members, 649 Members, 1 Junior Member, 115 Associate Members and 26 Corporate Members.

MEMBERSHIP

September 1, 1943. Honorary Members, Total		8		
Withdrawals	0	0	8	
Elected: September 1, 1943	1		1	9
September 1, 1943. Members, Total		642		
Withdrawals:				
Resigned	4			
Died	21			
Dropped by Executive Committee	9			
Elected to Honorary Member	1	35	607	
Elected:				
September, 1943	13			
October, 1943	2			
November, 1943	3			
December, 1943	3			
January, 1944	2			
February, 1944	9			
March, 1944	5			
May, 1944	5		42	649
September 1, 1943. Junior Members, Total		1		
Withdrawals	0	0	1	
Elected	0		0	1
September 1, 1943. Associate Members, Total		114		
Withdrawals:				
Resigned	4			
Dropped by Executive Committee	3	7	107	
Elected:				
September, 1943	4			
December, 1943	1			

March, 1944	1			
May, 1944	2		8	115
September 1, 1943. Corporate Members, Total		22		
Withdrawals	0	0	22	
Elected:				
September, 1943	1			
March, 1944	1			
May, 1944	2		4	26
				800
September 1, 1944. Total Membership				800
September 1, 1943. Total Membership				787
Net Gain				13

ELECTIONS

Honorary Members

September 27, 1943. Harry E. Jordan. (1)

Members

September 27, 1943. Edward J. Beckwith, John E. Cox, Chester J. Ginder, Robert A. Glines, Irving S. Hazard, John F. Kenney, Charles E. Lane, Hugh J. McCauley, Ernest L. Morse, Frederick T. O'Hara, Richard T. Ricker, Norman S. Stearns, and Henry M. Wilkins. (13)

October 28, 1943. Robert W. Glasheen, Ralph W. Horne. (2)

November 18, 1943. Clarence E. Ferry, James J. Matera, and Fred E. Potter. (3)

December 16, 1943. John T. Broderick, Lucretius H. Ross, and Donald E. Stearns. (3)

January 20, 1944. Abraham C. Bolde and Joseph S. Strohmeyer. (2)

February 17, 1944. Robert E. Brown, Lt. Comdr. K. M. Clark, Harry B. Collins, Joseph C. Derby, Charles A. Forrest, Jr., James E. Fuller, Deane E. Hawkins, Joseph W. McCarthy, Jr., and Kenneth C. F. Thompson. (9)

March 16, 1944. Clarence J. Dougal, Harold D. Kilgore, Henry T. O'Connell, Ernest A. Snow, Jr., and Irving W. Whittle. (5)

May 18, 1944. Theodore B. Brink, Royal J. Goddard, Sgt. Karl Haartz, Gilbert E. Long, and John L. Ossolinski. (5)

Associate Members

September 27, 1943. Payne Dean & Co., The Dorr Co., Inc., Ferguson & Pascoe, and The Preload Co. (4)

December 16, 1943. James A. Munroe & Sons. (1)

March 16, 1944. Johnson-Barker Co. (1)

May 18, 1944. Ampco Metal, Inc., and Bridgeport Brass Co. (2)

Corporate Members

September 27, 1943. Town of Ipswich Water & Light Dept. (1)
March 16, 1944. Norwood Board of Selectmen. (1)
May 18, 1944. Lewiston (Maine) Public Works Dept., Portland (Conn.) Water Works. (2)

WITHDRAWALS

Members

Resigned: Theodore R. Kendall, John A. Kienle, George A. Reed, and George M. Warren. (4)

Died: Alton D. Adams, Horace J. Cook, J. R. Dangler, George A. Dickel, Samuel M. Ellsworth, Frederic H. Fay, H. T. Gidley, J. Allen Goguen, Charles E. Greene, Frank P. Hall, Paul Hansen, Harry C. Heermans, Moses J. Look, Arthur B. Marsden, Hugh McLean, Albert W. Powers, Franklin H. Robbins, Richard H. Royce, Lewis O. Thorpe, Joseph P. Wadhams, and Elton D. Walker. (21)

Dropped by Executive Committee: Ivan A. Buchanan, Harold C. Chandler, Charles B. Cole, Thomas J. Fleming, Laroy G. Harris, Ralph A. Marble, Wilfred L. Newman, Michael B. Oates, and David Rudolph Smith. (9)

Associate Members

Resigned: F. S. Brainard & Co., National Gunite Contracting Co., Omega Machine Co., and Paint Engineers, Inc. (4)

Dropped by Executive Committee: Birch Mfg. Co., Hill, Hubbell & Co., and Perrin, Seamans & Co., Inc. (3)

RECEIPTS FOR THE FISCAL YEAR SEPTEMBER 1, 1943 TO SEPTEMBER 1, 1944.

Entrance Fees			$ 242.50
Annual Dues:			
Members	$3,052.60		
Corporate Members	220.00		
Associate Members	2,200.00		
Junior Members	3.00	$5,475.60	
Fractional Dues:			
Members	106.50		
Corporate Members	15.00		
Associate Members	45.00	166.50	
Past Dues:			
Members	204.00		
Associate Members	60.00	264.00	

1944-1945 Dues:			
Members	1,099.50		
Corporate Members	100.00		
Associate Members	1,260.00		
Junior Members	3.00	2,462.50	
Total Dues			8,368.60
Dividends and Interest			381.36
Advertisements			3,091.00
Subscriptions			542.20
Journals			160.25
Reprints			8.52
Membership Certificates			22.50
Sundries			31.70
Total Receipts			$12,848.63
There is due the Association:			
Dues	$ 321.00		
Advertisements	37.00		
Subscriptions	12.00		370.00
Total			$13,218.63

N.B. Dues of 35 members who are in our armed forces or in enemy occupied countries have been remitted for the duration.

Respectfully submitted,

(*Signed*) FRANK J. GIFFORD, *Secretary*.

ANNUAL REPORT OF THE TREASURER

Boston, September 16, 1944

To Frank J. Gifford, Treasurer,
New England Water Works Association,
Boston, Massachusetts.

We have examined the statement of assets and funds and the statement of cash receipts and disbursements of the general fund of the New England Water Works Association for the fiscal year ended August 31, 1944. In connection therewith we have reviewed the accounting procedures of the association and have examined accounting records of the association and other supporting evidence, by methods and to the extent we deemed appropriate.

We traced all recorded receipts into the depository bank, verified the general fund bank account and petty cash fund as at August 31, 1944, and examined properly approved vouchers for all disbursements. We also verified by direct communication the investment funds on deposit in savings banks, and on September 11, 1944 we examined the United States War Savings Bonds at the First National Bank of Boston.

In our opinion, the accompanying statement of assets and funds and the note thereon and the related general fund cash statement present fairly the position of the New England Water Works Association at August 31, 1944, and the recorded cash receipts and disbursements for the fiscal year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(*signed*) SCOVELL, WELLINGTON & COMPANY

STATEMENT OF ASSETS AND FUNDS (EXHIBIT A)
As at August 31, 1944
Assets

Cash in Banks, Invested Funds	
Farmers and Mechanics Savings Bank, Framingham, Massachusetts	$1,068.46

Franklin Savings Bank, Boston, Massachusetts	1,000.00	
Haverhill Savings Bank, Haverhill, Massachusetts	1,000.00	
Home Savings Bank, Boston, Massachusetts	1,000.00	
Mechanics Savings Bank, Reading, Massachusetts	1,000.00	
Pentucket Savings Bank Haverhill, Massachusetts	1,000.00	
The People's Savings Bank, Worcester, Massachusetts	1,000.00	
Suffolk Savings Bank Boston, Massachusetts	1,000.00	8,068.46
Securities		
United States War Savings Bonds G 2½s, 1954		10,000.00
Total Invested Cash and Securities		18,068.46
General Fund		
Cash, First National Bank of Boston	5,255.34	
In Office	50.00	
	5,305.34	
Furniture and Fixtures	1,180.00	6,485.34
		$24,553.80

Funds

Invested Funds		$18,068.46
General Fund		
Balance, August 31, 1943	3,737.90	
Add Excess of Receipts over Disbursements, Exhibit B	2.747.44	
Balance, August 31, 1944		6,458.34
		$24,553.80

Note: The statement above, prepared on a cash basis, includes dues received in advance, $2,462.50, and employees' withholding tax, $23. It does not reflect the following:

Accounts Receivable, Dues	$ 321.00

Due on Account of Advertising and Other Miscellaneous Charges		49.00
		$ 370.00

No depreciation has been taken on Furniture and Fixtures.

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS (EXHIBIT B)

General Fund

For the Year Ended August 31, 1944

Receipts (exclusive of dues received in advance and employees' withholding tax)			
Initiation Fees		$ 242.50	
Dues, 1943-1944 and Prior Years		5,906.10	
Interest		381.36	
From Publication of Journal			
Advertisements	3,091.00		
Subscriptions	542.20		
Sale of Journal	160.25		
Sale of Reprints	8.52		
Sale of Halftones, Electros, etc.	11.72	3,813.69	
Miscellaneous			
Membership Certificates	22.50		
Sundry	19.98	42.48	
Total Receipts			$10,386.13
Disbursements			
Publication of Journal			
Printing	2,416.23		
Plates	138.91		
Reporting	211.44		
Stationery and Postage	119.71		
Editor's Salary	500.00		
Sundry	20.19	3,406.48	
Office and General			
Certificates of Membership	12.98		
Secretary's Salary	400.00		
Assistant to Secretary—Salary	1,831.20		
Treasurer's Salary	100.00		
Treasurer's Bond	12.50		
Printing, Postage and Stationery	222.49		
Office Supplies and Expense	115.40		

Office Rent	1,200.00		
Electricity	66.99		
Telephone and Telegraph	182.83		
Auditing	65.00		
Social Security Taxes	129.83		
Office Assistance	180.00		
Sundry	115.51	4,634.73	
Meetings and Committees			
Badges	48.86		
Water Works School	125.00		
Water and Sewage Works Development Committee	606.10		
War Time Water Works Information Committee	328.20		
Printing, Postage and Stationery	641.68		
Convention Expense	41.86		
Sundry Expense	291.28	2,082.98	
Total Disbursements			$10,124.19
Excess of Receipts over Disbursements (exclusive of dues received in advance and employees' withholding tax)			261.94
Dues Received in Advance		2,462.50	
Employees' Withholding Tax		23.00	2,485.50
Excess of Receipts over Disbursements, Exhibit A			2,747.44
Balance, General Cash, August 31, 1943			2,557.90
Balance, General Cash, August 31, 1944 Represented by			
Cash in First National Bank of Boston		5,255.34	
Cash in Office		50.00	
			$5,305.34

ANNUAL REPORT OF THE EDITOR

To the New England Water Works Association:

The Editor submits herewith the following report for the year ending August 31, 1944.

As has been customary in the past, the tables of financial figures, accompanying the report, are based upon total charges and accounts receivable, rather than actual cash received or disbursed. A detailed statement of the receipts and disbursements on account of the September and December, 1943, and March and June, 1944, issues of the JOURNAL is included in the Report of the Treasurer.

TABLE 1.—STATEMENT OF MATERIAL IN SEPTEMBER AND DECEMBER, 1943, AND MARCH AND JUNE, 1944, ISSUES OF THE JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION

	Papers	Proceed-ings	Total Text	Index	Adver-tise-ments	Cover & Con-tents	Insert Plates	Total	Total Cuts
Sept., 1943	87	27	114	0	38	4	0	156	4
Dec., 1943	81	45	126	6	38	4	0	174	8
March, 1944	83	5	88	0	40	4	1	133	7
June, 1944	76	38	114	0	40	4	0	158	8
Total	327	115	442	6	156	16	1	621	27

Table 2 gives a comparison of the JOURNAL for the past year with preceding years.

Size. The four issues contained 621 pages, of which 442 were text.

Cost. The gross cost of the JOURNAL was $3,406.48, equivalent to $4.26 per member; the net profit was $407.21, equivalent to $0.51 per member.

Reprints. Reprints of papers have been furnished to authors at cost.

TABLE 2.—COMPARISONS OF JOURNALS OF THE NEW ENGLAND WATER WORKS ASSOCIATION. FOUR ISSUES FOR FISCAL YEAR ENDING AUGUST 31.

	1935	1936	1937	1938	1939	1940	1941*	1942‡	1943**	1944
Average edition (copies printed)	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,175	1,200
Average membership	786	770	772	785	795	796	800	803	798	799
Circulation at end of year	918	903	920	943	946	967	943	982	969	1,015
Pages of text	470	477	423	510	488	565	540	575	442	442
Pages of text per 1,000 members	598	619	561	650	614	710	675	716	554	553
Total pages, all kinds	643	642	627	699	670	762	733	757	616	621
Total pages, per 1,000 members	808	834	812	890	843	957	918	943	772	777
GROSS COST:										
Total	$4,780.75	$5,880.68	$5,040.86	$4,658.05	$4,119.30	$3,846.46	$4,415.00	$4,053.47	$4,234.68	$3,406.48
Per copy	1.09	1.35	1.23	1.06	0.94	0.87	1.00	0.93	0.90	0.71
Per page	7.54	9.16	8.04	6.66	6.15	5.05	5.66	5.36	6.87	5.49
Per member	6.08	7.64	6.53	5.93	5.18	4.33	5.52	5.05	5.31	4.26
Per member per 1,000 pages	9.46	11.89	10.41	8.49	7.13	6.34	7.53	6.67	8.61	6.87
Per member per 1,000 pages of text	12.93	16.01	15.01	11.63	10.61	8.55	10.21	8.78	12.01	7.71
NET COST:										
Total	$1,332.99	$1,499.58	$489.13	$539.21	$306.77†	$618.37†	$276.54	$534.72	$609.81	$407.21†
Per copy	0.30	0.34	0.11	0.12	0.07†	0.14†	0.06	0.12	0.13	0.08†
Per page	2.07	2.34	0.78	0.77	0.46†	0.81†	0.38	0.71	0.99	0.66†
Per member	1.70	1.95	0.63	0.69	0.39†	0.78†	0.35	0.67	0.76	0.51†
Per member per 1,000 pages	2.64	3.03	1.01	0.98	0.58†	1.02†	0.47	0.88	1.24	0.82†
Per member per 1,000 pages of text	3.61	4.08	1.46	1.35	0.80†	1.37†	0.64	1.16	1.73	0.92†

*Including comprehensive index, 1882 to 1939, and 102 pages of standard specifications.
‡Profit.
‡Including 45 pages of standard specifications.
**Including 28 pages of standard specifications.

Circulation. The present circulation of the JOURNAL is:

Members, all grades	800
Subscribers	131
Exchanges	22
Advertisers	62
Total	1,015

JOURNALS have been sent to all subscribers and to advertisers.

Respectfully submitted,

(*signed*) GORDON M. FAIR, *Editor.*

ANNUAL REPORT OF THE FINANCE COMMITTEE

To the Executive Committee of the New England Water Works Association

August 31, 1944.

Gentlemen:

Your Finance Committee herewith presents its report on the budget for the year 1944-1945 in accordance wth Article 6, Section 7 of the Constitution of the Association.

Preliminary to setting up the budget for the ensuing year the Committee examined the books of the Association with reference to revenues and expenditures for the fiscal year closing August 31, 1944.

The Committee considered the possible activities of the Association which it may be called upon to participate in during the year to come with reference to the partial restoration of normal water works activities.

It is the sense of the Committee in view of the likely removal, in the near future, of some of the restrictions on water works materials and activities, that delayed extension work and maintenance programs may soon get under way. In such an event it is felt that increased committee activities may be necessary to investigate and report on post-war problems, regulations, recommended policies, and the use of Government stock piles. It was, therefore, considered advisable to provide for such committee work in the budget.

The overall picture of the finances of the Association is much brighter than a year ago with no deficit and a splendid increase in revenue. This should reduce some of the deficit of last year.

During the year the following changes have occurred in the membership roster—

	Resigned	Deaths	Dropped	New	Gain
Members	4	21	9	42	8
Corporate members	0	0	0	10	10
Associate members	4	0	3	6	6
Totals	8	21	12	58	17

The above figures should have some effect on the budget for the next year.

In making up the budget we considered receipts and expenditures.

An analysis of the records for the closing year may be found in the following:

REVENUE FOR 1943-1944

	Budget	Actual	Difference
Initiation fees	60.00	241.50	182.50 balance
Dues	5,000.00	5,906.10	906.10 balance
Interest and dividends	300.00	381.36	81.36 balance
Journal	3,600.00	3,813.69	213.69 balance
Miscellaneous	25.00	36.48	11.48 balance
Totals	8,985.00	10,380.13	1,395.13 balance

EXPENDITURES FOR 1943-1944

	Budget	Actual	Difference
Office	4,800.00	4,611.73	188.27 balance
Journal	4,200.00	3,406.48	793.52 balance
Meetings and Committees	1,200.00	2,082.90	182.98 deficit
Water and Sewage Works Development Committees	Included under Meetings and Committees		
Miscellaneous	250.00	0	250.00 balance
Totals	11,150.00	10,101.19	1,048.81 balance
	Profit for the year	$278.94	

Dues paid in advance total $2,462.5 of which $2,444.00 were paid in August, and are entered under next year's revenue.

The books were balanced on September 1 with $5,255.34 on hand, in the checking account.

It will be noted that there has been a substantial increase in revenue, particularly with reference to receipts for dues in spite of the fact that this is a war year and that the dues of the members in the armed service are remitted. It is well at this point to commend the secretarial staff which has followed the recommendation of last year's Finance Committee that a drive should be made to collect outstanding dues. The efforts to this end have been noteworthy and are reflected in the above figures.

Under the expense heading it is gratifying to note a decrease

in office and JOURNAL costs. By combining the items "Meetings and Committees" and the special appropriation for the "Water and Sewage Works Development Committees", it will be noted that there is a deficit of $182.98. The latter committee comprises a National Group which is making an extensive analysis of post-war work to be inaugurated immediately at the end of the war. This work has entailed the employment of a field director and the setting up of a publicity program. An estimated budget covering the work of this committee was set at $18,000, the cost of which was allocated to several organizations with $588.00 of this amount to be assumed by our Association. On the recommendation of last year's Finance Committee this amount was increased to $700.00. The heaviest assessment of this amount of $18,000.00 was assumed by the Water and Sewage Manufacturer's Association in the amount of $10,000.00.

In making up the budget for the ensuing year it was felt that receipts from initiation fees, Interest and Dividends, and JOURNAL, are somewhat static and should approximate those of the present year, whereas the question of receipts from dues involves the fact that the amount collected this year from that source comprises a substantial sum in back dues. It was felt that the estimate for the ensuing years should approximate the normal revenue which we have estimated to be $5,400.00.

BUDGET FOR 1944-1945, REVENUE

Initiation fees	$ 150.00
Dues	5,400.00
Interest and Dividends	325.00
JOURNAL	3,600.00
Miscellaneous and contingencies	75.00
Total	$9,550.00

The Committee is of the opinion that office costs should approximate $4,200.00, the JOURNAL $4,000.00, and Meetings and Committees $1,300.00. The sum of $50.00 has been recommended to cover contingencies.

BUDGET FOR 1944-1945, EXPENDITURES

In making up the budget we considered revenues and expenditures.

Office	$4,200.00
JOURNAL	4,000.00
Meetings and committees	1,300.00
Contingencies	50.00
Total	$9,550.00

It will be noted that the budget is balanced at $9,550.00.

On deposit in the checking account at the close of the fiscal year there is $5,255.34. Securities and bank deposits make up the following,

Bonds	$10,000.00
Savings account	8,068.00
Total	$18,068.00

Elsewhere in the Annual Report of the Association will be found the report of the Auditor.

Respectfully submitted,

(*signed*) WALTER B. BUSHWAY, *Chairman*
ALLAN F. MCALARY
MARK F. CROKER

ANNUAL REPORT OF THE COMMITTEE ON COMMITTEES

September 27, 1944

To the New England Water Works Association: This Committee appointed by the Executive Committee of the Association to promote coördination of committee activities in the Association and to promote the establishment of new technical committees where this seems advisable, submits a brief report. Under war conditions, many committee activities have had to be curtailed. The Committee on Committees has, however, continued its usual practice of communicating with the various committee chairmen to secure their ideas as to continuance of the committees and their plans with regard to reports. The Program Committee was advised as to those committees desiring to submit reports at the annual meeting.

During the year the Committee on Sanitary Hazards of Interior Piping, Fixtures and Water Storage Within Buildings and the Committee on Water Works Coöperation in Defense were discontinued. New joint committees with the American Water Works Association were appointed as follows: Committee on Wartime Activities; Committee on Reinforced Concrete Pressure Pipe; Committee on Laying Cast Iron Pipe; Committee on Specifications on Steel Pipe; Committee on Valve Box Frames and Covers; and Committee on Threads for Underground Service Lines. Also appointed was a Committee on Classification of Waterworks Employees and Salaries.

No technical committee is planning to submit a final report at the coming annual meeting.

The following committees will either submit progress reports or in the opinion of this committee they should be continued, even though many committee chairmen state that little can be accomplished by their committees until after the war.

Committee on Finance.
Committee on Technical Program.
Committee on Membership.

Committee on Code for Pressure Piping (Joint Committee with A.S.M.E.)
Committee on Coefficients for Friction in Pipe Lines.
Committee on Specifications for Cast Iron Pipe and Special Castings (Sectional Committee under A.S.A.)
Committee on Standardization of Pipe Flanges and Fittings (Sectional Committee under A.S.A.)
Committee on Water Works Education.
Committee to Investigate Grounding (Coöperating with the American Research Committee on Grounding).
Committee on Meter Specifications (Joint Committee with A.W.W.A.)
Committee on Rainfall and Yield of Drainage Areas.
Committee on Water Quality Tolerances for Industrial Uses.
Committee on Library.
Committee on Legislation.
Committee on Reciprocal Relations with the Institution of Water Engineers (England).
Committee on Survey of Ground Water Supplies in New England.
Committee on Sluice Gates (Coöperating with committee of A.W.W.A.).
Committee to Report on Developments in our Knowledge of Corrosion and Its Mitigation.
Committee on Committees.
Committee on Cathodic Protection of Steel Tanks and Standpipes.
Committee on Hydrant Specifications (Joint Committee with A.W.W.A.).
Committee on Postwar Activities (Joint Committee with N.E.S.W.A.).
Committee on Wartime Water Works Information.
Committee on Gate Valves (Joint Committee with A.W.W.A.).
Committee on Steel Standpipes and Elevated Tanks (Joint Committee with A.W.W.A.).
Committee on Water and Sewage Works Development (Joint Committee with A.W.W.A., F.S.W.A., and W. & S.W.M.A.).

Committee on Survival and Retirement Experience with Water Works Facilities (Joint Committee with A.W.W.A.).
Committee on Classification of Water Works Employees and Salaries.
Committee on Valve Box Frames and Covers (Joint Committee with A.W.W.A.).
Committee on Threads for Underground Service Lines (Joint Committee with A.W.W.A.).
Committee on Wartime Activities (Joint Committee with A.W.W.A.).
Committee on Reinforced Concrete Pressure Pipe (Joint Committee with A.W.W.A.).
Committee on Laying Cast Iron Pipe (Joint Committee with A.W.W.A.).
Committee on Specifications on Steel Pipe (Joint Committee with A.W.W.A.).

New Committees. It is unfortunate that the war must of necessity interfere with normal committee activities. This Committee has suggested in the past and again suggests now that too little is being done to advise the public as to developments in the water works field and to emphasize the importance of the water works profession. The Association should consider the appointment of a committee on publicity or the adoption of a plan for paid publicity to promote the utilization of the press for this purpose.

The New England Water Works Association has no representative on the advisory committee appointed by the U. S. Public Health Service on "Public Health Service Drinking Water Standards". Considerable discussion of these standards has ensued during the past year, and several water works associations have taken exception to certain features of these standards. It is recommended that a Committee on Water Supply Standards be appointed to keep the membership advised as to developments, pending a possible revision of these standards.

War Activities. It is natural that during wartime, committee activities should be directed toward the war program and the period to follow the war. There are four committees dealing with such sub-

jects: Committee on Postwar activities; Committee on Wartime Water Works Information; Committee on Wartime Activities; and Committee on Water and Sewage Works Development. The last two committees are joint with the American Water Works Association and the first has functioned jointly with the New England Sewage Works Association. There seems to be some duplication in the activities of these committees, but there will probably be little harm in keeping them as they are during the war. The membership is more or less interwoven.

Conclusions and Recommendations. It is recommended that the standing committees listed be reappointed. The times do not appear to warrant extensive committee assignments now except as they relate to the war effort in which water works maintenance is closely involved. Postwar planning in the water works field, however, does appear to merit study now so as to provide a program for cushioning the after-effects of the war; committee assignments in this field are discussed in this report. Possible appointment of committees on publicity and water supply standards should be considered.

Respectfully submitted,

(*signed*) WARREN J. SCOTT, *Chairman*
THOMAS R. CAMP
HARRY U. FULLER
ARTHUR C. KING
ARTHUR L. SHAW

APPENDIX

COMMITTEES OF THE NEW ENGLAND WATER WORKS ASSOCIATION 1944-1945

Committee on Committees: Warren J. Scott, *Chairman,* Thomas R. Camp, Harry U. Fuller, Arthur C. King, Arthur L. Shaw.

Committee on Specifications for Cast Iron Pipe and Special Castings (Sectional Committee under the American Standards Association): William R. Conard, *Chairman,* Arthur L. Shaw.

Committee on Cathodic Protection of Steel Tanks and Standpipes: Donald C. Calderwood, *Chairman,* Richard H. Ellis, Harry U. Fuller, Madison H. Goff, William P. Melley.

Committee on Classification of Water Works Employees and Salaries: Walter B. Bushway, *Chairman,* Walter G. Conroy, Roger G. Oakman, George S. Ryan, Allen M. Symonds.

Committee on Code for Pressure Piping (Joint Committee with the American Society of Mechanical Engineers): Thomas F. Wolfe.

Committee on Coefficients for Friction in Pipe Lines: Elson T. Killam, *Chairman,* Frank A. Barbour, William W. Brush, William F. Covil.

Committee to Report on Developments in Our Knowledge of Corrosion and Its Mitigation: Edward M. Moore, Chairman, Lazarus Rubin, Walton H. Sears.

Committee to Report on Developments in Water Quality Standards: Arthur D. Weston, *Chairman,* Almon L. Fales, Melville C. Whipple.

Committee on Finance: Mark F. Croker, *Chairman,* Allan F. McAlary, William P. Melley.

Committee on Hydrant Specifications (Joint Committee with the American Water Works Association): Roger W. Esty, *Chairman,* Harry U. Fuller, Harold W. Griswold.

Committee on Gate Valves (Joint Committee with the American Water Works Association): Harold W. Griswold, Chairman, Leland G. Carlton, Walton H. Sears.

Committee to Investigate Grounding (Coöperating with the American Research Committee on Grounding): George A. Sampson, *Chairman,* Warren A. Gentner, Arthur V. Harrington, Edward E. Minor.

Committee on Laying Cast Iron Pipe (Joint Committee with American Water Works Association): W. S. Mariner, *Chairman,* Madison H. Goff.

Committee on Legislation: Arthur C. King, *Chairman,* Sidney S. Anthony, Theodore L. Bristol, Madison H. Goff, Philip J. Holton, Jr., Percy R. Sanders, Edward L. Tracy.

Committee on Library: E. Sherman Chase, *Chairman,* Francis H. Kingsbury.

Committee on Membership: Allan F. McAlary, *Chairman,* William H. Doggett, Roger W. Esty, C. P. Moat, Ernest E. Tankard, James V. Turner, David C. Wiggin, Jr.

Committee on Meter Specifications (Joint Committee with the American Water Works Association): Richard H. Ellis, *Chairman,* Warren A. Gentner, D. H. Hall.

Committee on Post-War Activities (Joint Committee with the New England Sewage Works Association): E. Sherman Chase, *Chairman,* Theodore Cate, Richard H. Ellis, Harold W. Griswold, J. Elliott Hale, G. E. Hawkins, Philip J. Holton, Jr., Howard H. Potter, Fred J. Reny, Warren J. Scott, Walter J. Shea, Edward L. Tracy, Arthur D. Weston.

Committee on Rainfall and Yield of Drainage Areas: Arthur D. Weston, *Chairman,* Harold K. Barrows, Allan T. Gifford, Richard S. Holmgren, Francis H. Kingsbury, Harvey B. Kinnison, Elbert E. Lockridge, Arthur T. Safford, Caleb M. Saville, Ralph M. Soule, Miner R. Stackpole, James L. Tighe.

Committee on Reciprocal Relations with the Institution of Water Engineers (England): E. Sherman Chase, *Chairman,* Leland G. Carlton, Percy A. Shaw.

Committee on Reinforced Concrete Pressure Pipe (Joint Committee with American Water Works Association): Stanley M. Dore, *Chairman,* George A. Sampson.

Committee on Sluice Gates (Coöperating with Committee of the American Water Works Association): William R. Conrad, *Chairman,* Harold W. Griswold.

Committee on Standardization of Pipe Flanges and Fittings (Sectional Committee under the American Standards Association): William R. Conard, *Chairman,* Frank A. Barbour.

Committee on Specifications on Steel Pipe (Joint Committee with American Water Works Association): Frank A. Barbour.

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Committee on Steel Standpipes and Elevated Tanks (Joint Committee with American Water Works Association): George A. Sampson, *Chairman,* Harry U. Fuller, Henry E. Halpin.

Committee on Survey of Ground Water Supplies in New England: Leslie K. Sherman, *Chairman,* Joseph C. Knox, Howard H. Potter, Walter J. Shea, Edward L. Tracy, Leonard Trager.

Committee on Survival and Retirement Experience with Water Works Facilities (Joint Committee with American Water Works Association): Reeves Newsom, *Chairman,* Harry U. Fuller, Arthur V. Ruggles, Thomas H. Wiggin.

Committee on Technical Program: Joseph C. Knox, *Chairman,* Frederick O. A. Almquist, Thomas R. Camp, Gordon M. Fair, J. Elliott Hale, Paul F. Howard, Roger G. Oakman.

Committee on Threads for Underground Service Lines (Joint Committee with American Water Works Association): William W. Brush, *Chairman,* Donald C. Calderwood.

Committee on Valve Box Frames and Covers (Joint Committee with American Water Works Association): Sidney S. Anthony, *Chairman,* Scott Keith.

Committee on Wartime Activities (Joint Committee with American Water Works Association): Sidney S. Anthony, *Chairman,* Fred S. Gibbs.

Committee on Water and Sewage Works Development (Joint Committee with American Water Works Association, Federation of Sewage Works Associations, and Water and Sewage Works Manufacturers Association): E. Sherman Chase, *Chairman,* Roger W. Esty.

Committee on Water Quality Tolerances for Industrial Uses: Edward W. Moore, *Chairman,* Stuart E. Coburn, Louis A. Olney, Hervey J. Skinner, George A. Sampson.

ANNUAL REPORT OF THE LEGISLATIVE COMMITTEE

To the New England Water Works Association: Your Legislative Committee has little to report this year inasmuch as Rhode Island was the only New England State in which the legislature sat in regular session.

There are, however, two legislative matters in Massachusetts which we believe should be mentioned.

The first is something which should be watched a little later this year. This is the report due on or before November first from a special commission making an investigation relative to certain problems arising from the holding of property in the Commonwealth for public purposes.

Unquestionably the purpose of this investigation is to increase income by taxes, and there is considerable likelihood that water systems owning property in more than one town may have a serious financial load added by taxation, if there is no definite active opposition.

The second item is an act already passed as an amendment to Chapter one hundred and forty-nine, by adding four new sections following section forty-four.

This act is entitled "An act requiring fair competition for bidders on the construction, reconstruction, alteration, remodeling or repair of certain public works by the Commonwealth or any political subdivision thereof."

This act was called to our attention by a member of the association who had been affected by it, unexpectedly. It is applicable to contracts awarded by commissions and districts, as well as by other town and city officials.

It applies to contracts of over $1,000 for public building construction, and one of the requirements is that sub-bidders shall file their bids with the awarding authority as well as with the general contractor two days before the date for general contract bids. Names of sub-bidders who filed bids shall be mailed on the date of receipt

to the general contractors bidding. No sub-bidder not on the list may be included in a general contractor's bid.

This is a lengthy act, giving in detail much of the procedure, including proposal forms, and should be studied carefully when specifications are being prepared for contracts within its scope.

Respectfully submitted,

(*signed*) ARTHUR C. KING, *Chairman*
SIDNEY S. ANTHONY
THEODORE L. BRISTOL
MADISON H. GOFF
PHILIP J. HOLTON, JR.
PERCY R. SANDERS
EDWARD L. TRACY

ANNUAL REPORT OF THE COMMITTEE ON RECIPROCAL RELATIONS WITH THE INSTITUTION OF WATER ENGINEERS

September 19, 1944

To the New England Water Works Association: Continuation of the war in Europe has of necessity limited the activities of your Committee on Reciprocal Relations with the Institution of Water Engineers of England.

We have continued as in past years to correspond with Mr. Gourley of a similar committee of the Institution of Water Engineers, and Mr. Cronin, Chief Engineer of the London Metropolitan Water Board. It will be of interest to you that Mr. Gourley has been made an honorary member of the Institution of Water Engineers, and that Mr. Cronin has been made a Commander of the British Empire, an honor bestowed by the Crown. It has been previously called to your attention that one of our English members, William Paterson, was knighted last New Year's. It is gratifying to know that the value of the water works profession is recognized in England.

With the approach of the collapse of Germany and the return of more normal conditions in both the United States and England, we believe that during the coming year more active relations with the Institution should be established. The last Reciprocal Paper was sent to us in 1941 by Mr. John Bowman, Past President of the Institution. Except for two papers presented in 1931, no paper from members of our Association has been sent to the Institution. It is high time that the New England Water Works Association take steps to remedy this situation.

We recommend that the Executive Committee select some member of this Association to prepare and transmit during the coming year to the Institution of Water Engineers a worthy paper upon some phase of water works practice in United States.

Respectfully submitted,

(*signed*) E. SHERMAN CHASE, *Chairman*
LELAND G. CARLTON
PERCY A. SHAW

REPORT OF COMMITTEE ON WAR TIME ACTIVITIES

September 1, 1944

To the New England Water Works Association: Your Committee on War Time Activities works in conjunction with a similar committee of the American Water Works Association and included the late Samuel M. Ellsworth of Boston, representing the New England Water Works Association.

The committee work was almost entirely conducted by mail with the exception of one meeting in Washington on December 2, 1943 when a group of water works operators and engineers from widely scattered sections of the country were called in consultation with the War Production Board to discuss manpower problems among water utilities, a question that at that time was becoming extremely acute.

Later, in the early Summer of this year, however, changing requirements of the military largely removed the problems of loss of personnel to Selective Service.

It appeared from discussions early in the meeting of December 2, 1943, that labor turnover involving loss of personnel to competing war industry had in the past constituted an even graver problem to water utilities than loss of personnel to the armed services. There are many influencing factors here such as intensity of war activity, type of labor market, unionization, civil service, and manpower freezes, most of which define the problem of each utility as a local one. Greater stabilization in the field of labor relations apparently is in prospect for the future, and it is believed that the critical stage insofar as the effect upon water utility organizations is concerned is past.

The complete report of the Task Committee will be submitted to the Secretary for inclusion in the records of the Association.

The Office of War Utilities of WPB frequently during the past year submitted to members of this Task Committee proposed revisions of Utility Order U-1 and Priorities Regulations affecting water utilities. This practice was instrumental in making these regulations

more palatable to utility operators and brought the WPB and water utilities closer together in their points of view. Each group became aware of the problems of the other and close coöperation was achieved.

The Committee also coöperated with the Committee on Water and Sewage Works Development of AWWA in disseminating information to all members on the "Blue Print Now" plan.

Much literature was distributed to members, speakers, were arranged for and we feel that the idea is well planted in the minds of all members of this Association, so that when the need arises for jobs, they are and will be ready on short notice, jobs that have an economic justification, creating new wealth at a reasonable expenditure of local funds.

There is no need for the inhabitants of Augusta, Maine, for example, to help pay for a water treatment plant in New Mexico, nor should the taxpayers of New Mexico bear the entire cost of harbor improvements in Boston. The cost of post-war public works of all types should be properly allocated over the area which will be benefited, a water supply to the community involved, secondary highways to the state, flood control works to the river valley, probably in more than one state, and major navigational improvements to the nation as a whole.

Several bulletins were issued to the membership informing them of the most recent developments in the matter of priorities and controlled materials, and the subject of surplus materials has been closely followed by the Committee.

The release from inventories of copper water service tubing and the permission to manufacture bronze case meters earlier this year were made possible by the representations made to WPB by the members of the Joint committee through Harry Jordan, Secretary of the American Water Works Association.

It was considered earlier in the year that conditions apparent then and in the near future made it unnecessary to issue bulletins as frequently as in the past. The materials and manpower situation has been stabilized now to the point where changes in regulations are likely to be of a minor nature and completely and thoroughly explained by the Office of War Utilities in a letter accompanying each revision.

Respectfully submitted,

(*signed*) SIDNEY S. ANTHONY

ANNUAL REPORT OF THE COMMITTEE ON LIBRARY

September 19, 1944

To the New England Water Works Association: The use of the library by the members of the Association has continued to be slight during the past year. No new books have been purchased, but the receipt of many current technical periodicals has continued as in the past.

Bound volumes of the JOURNAL of the New England Water Works Association, of the *Journal of the American Water Works Association,* and of the *Transactions of the Institution of Water Engineers* are kept in the permanent files. Other periodicals are retained only for the current and immediately preceding year. Members desiring to fill in gaps in their files should communicate with the Secretary's office if they desire to obtain copies of periodicals which would otherwise be discarded by our library. Requests for back numbers will be filled where possible in order of receipt of request.

Each year there accumulates a substantial number of extra copies of the JOURNAL of this Association. The price of single copies has been $1.25 for many years. In order to stimulate the sale of back numbers and to reduce the need for storage space, we recommend that the Executive Committee give consideration to cutting the price of spare copies of the JOURNAL over two years old to fifty cents to members of the Association, retaining, however, the price of $1.25 to non-members.

Respectfully submitted,

(*signed*) E. SHERMAN CHASE, *Chairman*
FRANCIS A. KINGSBURY

OBITUARY

HENRY T. GIDLEY

Henry T. Gidley, an esteemed citizen of Fairhaven and one active in its civic life, died suddenly March 3, 1944.

Mr. Gidley came to Fairhaven in 1913 as Superintendent of the Fairhaven Water Company, assuming the added position of Treasurer in 1926. Mr. Gidley was a birthright member of the Society of Friends, of sturdy New England heritage and typified in his life the best tradition of the Quaker stock of old Dartmouth.

He brought to his official position with the Water Company an engineering education and experience most useful to the Corporation and gave to it continuously a service skillful, conscientious and diligent. No jar or discord disturbed the genial relations with his associates.

He was quiet and unassuming in manner, of cheerful disposition, unquestioned integrity, a careful student of public interests, and ever ready to assume his share of civic duty. His life was an example of the dignified public spirited citizen who discharges the duties of his office with fidelity and efficiency.

THOMAS W. TRIPP

JOURNAL

of the

New England Water Works Association

VOLUME LVIII

1944

PUBLISHED BY
THE NEW ENGLAND WATER WORKS ASSOCIATION
613 STATLER BUILDING, BOSTON 16, MASS.

The four numbers composing this volume
have been separately copyrighted in
1943 and 1944
by the New England Water Works Association

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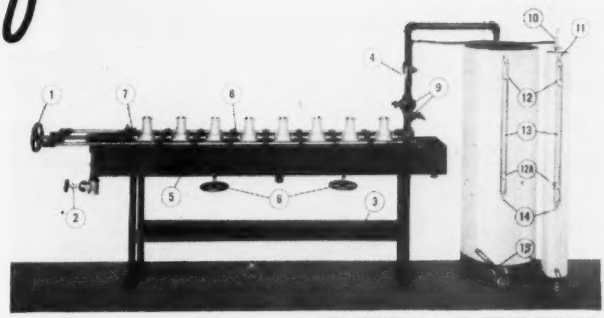

NEPTUNE No. 18B TEST BENCH

Neptune TEST Benches

Features of NEPTUNE TEST BENCHES

RAPID HANDLING OF METERS

EASE OF MAINTENANCE

SIMPLICITY OF CONTROL

FLEXIBILITY (will handle all sizes up to 2 inches)

ACCURACY
—of flow control
—of measured quantity
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NEPTUNE Test Benches have been brought well within the means of any Water Department. The bench, the tanks, the rate of flow indicator and the controls have been made of the highest quality material available, and yet have been kept simple and inexpensive in design. Everything for easy, accurate and rapid testing of meters has been incorporated.

● *Their value is proved by the results obtained by the great number already placed in service.*

A SIZE FOR EVERY REQUIREMENT

TABLE SHOWING NUMBER OF BENCH WITH SIZE AND NUMBER OF METERS FOR WHICH TEST FITTINGS ARE PROVIDED

Bench No.	Capacity of Bench in number of Meters						
	⅝	⅝ x ¾	¾	¾ x 1	1	1½"	2"
15	2	2	2	2	1	1	1
16	4	4	4	4	3	0	0
16B	4	4	4	4	3	2	2
17	6	6	5	6	5	0	0
17B	6	6	5	6	5	3	3
18	8	8	7	7	6	0	0
18B	8	8	7	7	6	5	4
19	10	10	9	9	8	0	0
19B	10	10	9	9	8	6	5

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Resists Corrosion

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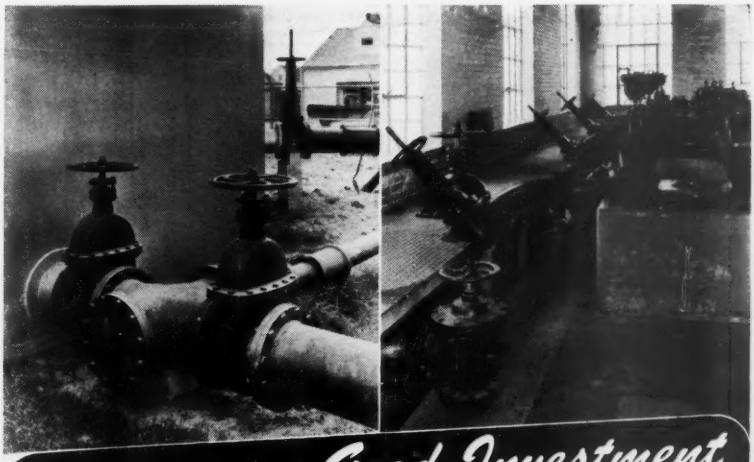

TAKE A LOOK AT A *Good Investment*

The above views of Ludlow Valve installations in the municipal water works at West University Place, Texas, illustrate a well-laid foundation for public approval.

Now, when we can look forward confidently to the increased relaxing of restrictions, is the time to make definite plans for needed improvements and additions to water systems. Ludlow Valves and Hydrants—long-lived, dependable—pay off in satisfaction and security—dividends worth getting for *your* community. W-1

Ludlow List 44. Flanged, Double Disc Gate Valve with OS&Y. Iron body, bronze mounted. Cold working pressure, 200 lbs. Test pressure 350 lbs. Can be repaired in the field much easier than the wedge-type gate valve.

LUDLOW VALVES and HYDRANTS

Catalogs sent on request. And we'll be glad at any time to aid you in planning water supply installations. No obligation.

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SINCE 1866
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A DEPENDABLE SELF-CAULKING JOINT COMPOUND FOR CAST IRON BELL AND SPIGOT WATER MAINS

HYDRO-TITE is a self-caulking sulphur base jointing compound used to joint bell and spigot cast iron water mains and soil pipe. It comes in powder form which insures uniformity and quick melting.

When poured into a joint, HYDRO-TITE immediately solidifies upon contact with the metal and bonds to both the surfaces of the bell and the spigot for the entire depth of the joint. It requires no caulking and after pouring a joint, water pressure may be immediately applied.

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WILL NOT BREED BACTERIA

A SANITARY Packing used in jointing bell and spigot pipe for water, sewer mains and soil pipe.

FIBREX was designed for use with Hydro-Tite and other self-caulking compounds, but is entirely suitable also for joints made with lead, and for Sani-Tite and other asphalt sewer joint compounds. Thousands of pounds of Fibrex are already in service on water lines throughout the country.

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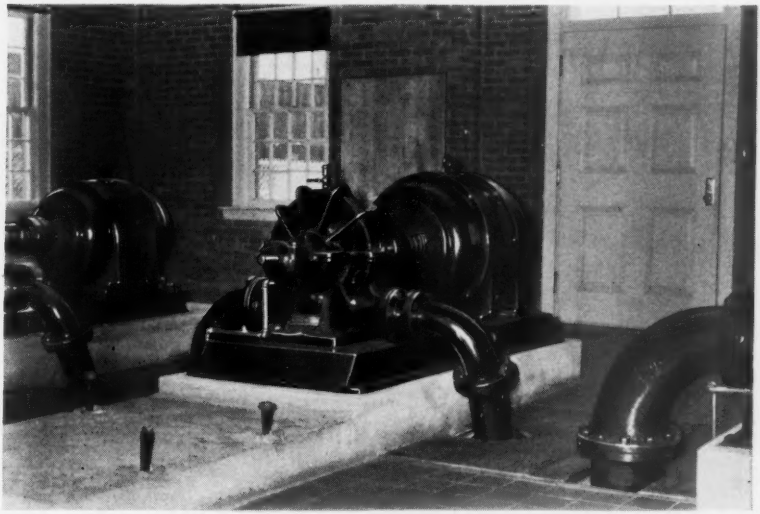

Methuen booster station able to move daily quota of 4½ million gallons with three Fairbanks-Morse centrifugals.

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There are no adjustments on a pump. It is designed and built to do one job. At this job it will work efficiently, and at any other it will not.

Fairbanks-Morse builds with the best of materials, workmanship and engineering research. The result is a line of uniformly good pumps. In addition, Fairbanks-Morse takes the utmost care to see that exactly the right pump is chosen for each job.

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Kennedy water gates are available in all sizes up to 60 in., with every type of pipe connection, and for any method of operation. Write for the Kennedy Catalog giving complete specifications, dimensions, lists, and also recommendations for accessories. This catalog also describes Kennedy Standard and Safetop Fire Hydrants.

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Valves and Hydrants

Distinctive Features of the EDDY Valves

ONLY three parts are moved by the Stem—the ball and the two gates. Each gate is hung from one of the trunnions on the ball. A convex surface at the base of each trunnion fits a concave surface on the back of the gate. This allows the gates to adjust themselves properly to their seats. . . . The gates, being free to revolve on the trunnions, do not always seat in the same position. Gates are center bearing and adjustable. They are forced to their seats with equal pressure at all points. There are two hooks on the ball on sizes 4-inch and larger, which loosely engage with the gates.

Distinctive Features of Our New Swivel Top Hydrants

THIS new hydrant has all the advantages of the popular EDDY fire hydrant, plus several additional features. . . . Nozzles are in a short flanged section of the standpipe, which may be unbolted and turned to different positions. . . . Should the standpipe be broken, only the casting below the swivel head need be replaced. . . . To raise the hydrant to conform to a new grading, simply insert a flanged extension piece below the swivelhead. No digging. To add a steamer nozzle at any time, it is only necessary to replace the swivel head with one having a steamer nozzle.

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Remember that joints caulked with lead are soft and flexible . . . take up normal pipe movement without leakage . . . stay tighter longer.

Remember, too, that there is no current shortage of lead . . . no ruling which prohibits the use of lead for caulking purposes.

We furnish lead either in ingot form for cast joints or as lead wool for cold caulking. Both carry the Lead Industries Association Seal of Approval—a guarantee of their purity.

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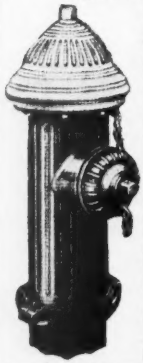

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Machines for inserting valves under pressure, and for making large right angle connections to mains under pressure, and for inserting house service connections under pressure.
Also makers of—
Pipe Cutting Machines, each size being adjustable for use on three different sizes of pipe.
High-grade water works supplies, such as Hydrants, Valves, Meters, Corporation Cocks, etc.
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"HYDRANT WITH BREAKABLE COUPLING"

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Special Castings for Water and Gas
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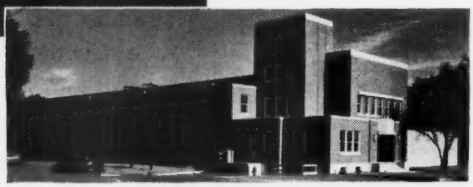
Water Needed for 6,000 New Homes!

One of the record-breaking Morris Pumps installed in the Wilmington Plant.

This new pumping plant is an important step in enabling Wilmington to compete with other southern cities for new industry.



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During the war boom the population of Wilmington, N. C., soared from 33,407 to over 100,000, and over 6,000 new housing units were constructed. The water supply became a problem even before the peak population was reached.

A new pumping plant was built and equipped with two Morris Pumps, one of 5-mgd capacity and one of 3-mgd capacity, pumping against a 200 ft. head. This installation, on December 16, 1943, during an unusually severe freeze, pumped over 6,200,000 gallons of water in 24 hours, to set a new pumpage record.

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2. High efficiencies for maximum economy under continuous operation.
3. Quietness of operation.
4. Trim, workmanlike appearance which harmonizes with up-to-date plant design.

If you contemplate changes or additions to your water plant, ask for information now about Morris Pumps to fit your particular needs. More than three-quarters of a century of pump building experience stands behind every Morris Pump.

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MORRIS
CENTRIFUGAL PUMPS

Replacing Old Pumps with New Pays Big Dividends

Many a New England Water Works is operating a pump which, even though not very old, is actually "eating its head off" in power bills.

Consider a typical case:

Rate of pumping—3 MGD **Current cost—2¢ kw/hr.**
Pumping head—231 ft. **5000 hrs. per year operation**
Assumed motor efficiency—88%

	Your Old Pump	*A New 1944 De Laval*
Pump Efficiency	**72%**	**83%**
B. H. P.	**170**	**147**
Electric H. P.	**193**	**167**

Power saved—19.4 kw. at 2¢ rate—38.8 cents/hour
Annual saving—5000 hrs. x .388 equals $1,940.00

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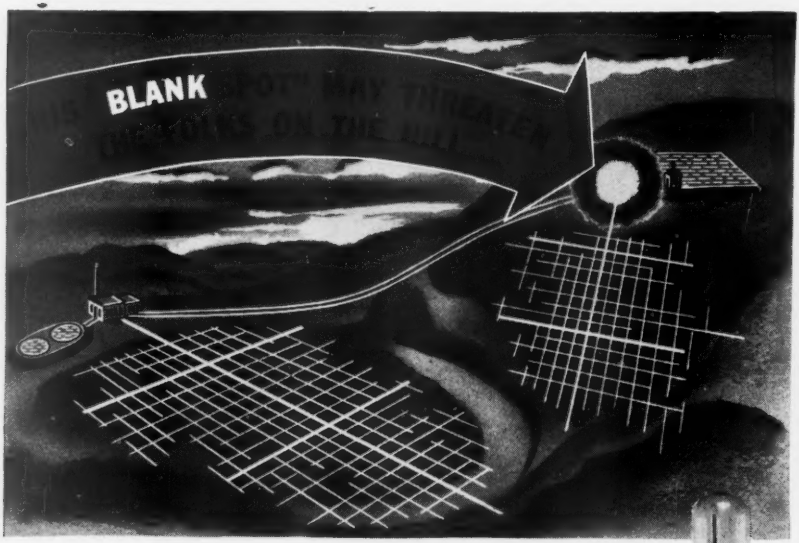

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Many cities are taking safety-plus precautions by providing secondary chlorination at the outflows of distribution reservoirs, floating reservoirs and finished water storage basins. Such secondary chlorination helps to maintain a free chlorine residual throughout the distribution mains.

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W&T "VISIBLE VACUUM" CHLORINATOR FOR AUTOMATIC PROPORTIONING OF CHLORINE TO THE FLOW OF WATER

"The Only Safe Water is a Sterilized Water"

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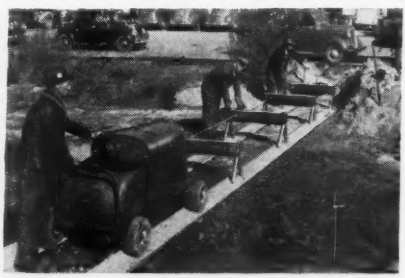

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The most practical way to meet today's overload demand is to clean clogged water mains. FLEXIBLE Underground Pipe-Cleaning Co., specializes in such jobs—any size—2″ to 72″.

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FOR

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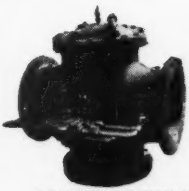
1879—ROSS— 1879

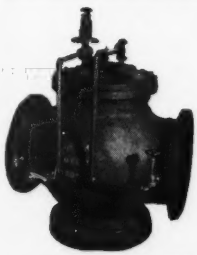
AUTOMATIC VALVES



Controls elevation of water in tanks, basins and reservoirs

ALTITUDE VALVE

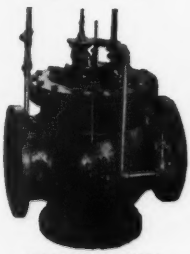
1. Single Acting
2. Double Acting



Maintains desired discharge pressure regardless of change in rate of flow

REDUCING VALVE

Regulates pressures in gravity and pump systems; between reservoirs and zones of different pressures, etc.



Maintains levels in tank, reservoir or basin

1. As direct acting

2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

FLOAT VALVE

A self contained unit, with three or more automatic controls

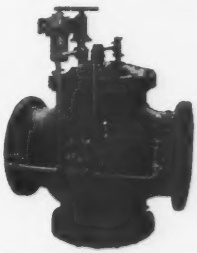
COMBINATION VALVE

Combination automatic control both directions through the valve.

Maintains safe operating pressures for conduits, distribution and pump discharge

SURGE-RELIEF VALVE

Electric remote control—solenoid or motor can be furnished



REMOTE CONTROL VALVE

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

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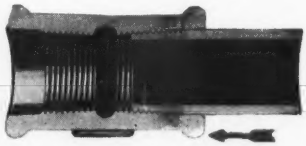

Joint
Strongest Point

FIG. 21

RED HED RECESSED

COUPLINGS, TEES AND ELBOWS

THOROUGHLY PROTECT THE PIPE

THREADS FROM DETERIORATION

AND BREAKAGE.

FEMALE ENDS MACHINED CLOSELY

TO FIT PIPE

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Manufacturers of

RED HED Brass Goods for Water Works

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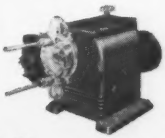

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"PROPORTIONEERS, INC."

Chemical Feeder Headquarters

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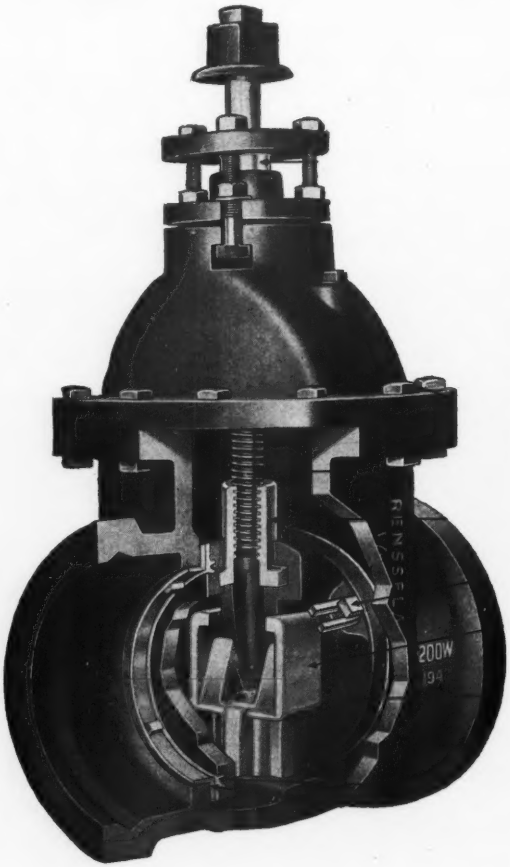

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to meet the most exacting requirements

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NEW YORK CHICAGO TULSA
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1 Piece	4" x 12'	6 Pieces	10" x 16'	15 Pieces	12" x 12'
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ESTABLISHED IN 1803
Made by R.D. WOOD Company
MANUFACTURERS OF SAND SPUN PIPE (CENTRIFUGALLY CAST IN SAND MOLDS) AND R. D. WOOD GATE VALVES

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